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# ADVERTISEMENT.

[Mineral Resources of the United States, 1885.]

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The publications of the United States Geological Survey are issued in accordance with the statute approved March 3, 1879, which declares that—

"The publications of the Geological Survey shall consist of the annual report of operations, geological and economic maps illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. The annual report of operations of the Geological Survey shall accompany the annual report of the Secretary of the Interior. All special memoirs and reports of said Survey shall be issued in uniform quarto series if deemed necessary by the Director, but otherwise in ordinary octavos. Three thousand copies of each shall be published for scientific exchanges and for sale at the price of publication; and all literary and cartographic materials received in exchange shall be the property of the United States and form a part of the library of the organization: And the money resulting from the sale of such publications shall be covered into the Treasury of the United States."

On July 7, 1882, the following joint resolution, referring to all Government publications, was passed by Congress:

"That whenever any document or report shall be ordered printed by Congress, there shall be printed, in addition to the number in each case stated, the 'usual number' (1,900) of copies for binding and distribution among those entitled to receive them."

Except in those cases in which an extra number of any publication has been supplied to the Survey by special resolution of Congress or has been ordered by the Secretary of the Interior, this Office has no copies for gratuitous distribution.

## ANNUAL REPORTS.

Of the Annual Reports there have been already published:

I. First Annual Report to the Hon. Carl Schurz, by Clarence King. 1880. 8°. 79 pp. 1 map.—A preliminary report describing plan of organization and publications.

II. Report of the Director of the United States Geological Survey for 1880–'81, by J. W. Powell. 1882. 8°. lv, 588 pp. 61 pl. 1 map.

III. Third Annual Report of the United States Geological Survey, 1881–'82, by J. W. Powell. 1883. 8°. xviii, 564 pp. 67 pl. and maps.

IV. Fourth Annual Report of the United States Geological Survey, 1882–'83, by J. W. Powell. 1884. 8°. xxxii, 473 pp. 85 pl. and maps.

V. Fifth Annual Report of the United States Geological Survey, 1883–'84, by J. W. Powell. 1885. 8°. xxxvi, 469 pp. 58 pl. and maps.

The Sixth and Seventh Annual Reports are in press.

## MONOGRAPHS.

Of the Monographs, Nos. II, III, IV, V, VI, VII, VIII, IX, X, and XI are now published, viz:

II. Tertiary History of the Grand Cañon District, with atlas, by Clarence E. Dutton, Capt. U. S. A. 1882. 4°. xiv, 264 pp. 42 pl. and atlas of 24 sheets folio. Price $10.12.

III. Geology of the Comstock Lode and the Washoe District, with atlas, by George F. Becker. 1882. 4°. xv, 422 pp. 7 pl. and atlas of 21 sheets folio Price $11.

IV. Comstock Mining and Miners, by Eliot Lord. 1883. 4°. xiv, 451 pp. 3 pl. Price $1.50.

V. Copper-bearing Rocks of Lake Superior, by Roland D. Irving. 1883. 4°. xvi, 464 pp. 15 l. 29 pl. Price $1.85.

VI. Contributions to the Knowledge of the Older Mesozoic Flora of Virginia, by Wm. M. Fontaine. 1883. 4°. xi, 144 pp. 54 l. 54 pl. Price $1.05.

VII. Silver-Lead Deposits of Eureka, Nevada, by Joseph S. Curtis. 1884. 4°. xiii, 200 pp. 16 pl. Price $1.20.

VIII. Paleontology of the Eureka District, by Charles D. Walcott. 1884. 4°. xiii, 298 pp. 24 l. 24 pl. Price $1.10.

IX. Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey, by Robert P. Whitfield. 1885. 4°. xx, 338 pp. 35 pl. Price $1.15.

X. Dinocerata. A Monograph of an Extinct Order of Gigantic Mammals, by Othniel Charles Marsh. 1885. 4°. xviii, 243 pp. 56 l. 56 pl. Price $4.75.

XI. Geological History of Lake Lahontan, a Quaternary Lake of Northwestern Nevada, by Israel Cook Russell. 1885. 4°. xiv, 288 pp. 46 pl. Price $1.75.

# ADVERTISEMENT.

The following is in press, viz:

XII. Geology and Mining Industry of Leadville, with atlas, by S. F. Emmons. 1886. 4°. xxix, 770 pp. 45 pl. and atlas of 35 sheets folio.

The following are in preparation, viz:

I. The Precious Metals, by Clarence King.
— Gasteropoda of the New Jersey Cretaceous and Eocene Marls, by R. P. Whitfield.
— Geology of the Eureka Mining District, Nevada, with atlas, by Arnold Hague.
— Lake Bonneville, by G. K. Gilbert.
— Sauropoda, by Prof. O. C. Marsh.
— Stegosauria, by Prof. O. C. Marsh.
— Brontotheridæ, by Prof. O. C. Marsh.
— Geology of the Quicksilver Deposits of the Pacific Slope, with atlas, by George F. Becker.
— The Penokee-Gogebic Iron-Bearing Series of North Wisconsin and Michigan, by Roland D. Irving.
— Younger Mesozoic Flora of Virginia, by William M. Fontaine.
— Description of New Fossil Plants from the Dakota Group, by Leo Lesquereux.
— Report on the Denver Coal Basin, by S. F. Emmons.
— Report on Ten-Mile Mining District, Colorado, by S. F. Emmons.
— Report on Silver Cliff Mining District, by S. F. Emmons.
— Flora of the Dakota Group, by J. S. Newberry.

## BULLETINS.

The Bulletins of the Survey will contain such papers relating to the general purpose of its work as do not properly come under the heads of Annual Reports or Monographs.

Each of these Bulletins contains but one paper and is complete in itself. They are, however, numbered in a continuous series, and may be united into volumes of convenient size. To facilitate this, each Bulletin has two paginations, one proper to itself and another which belongs to it as part of the volume.

Of this series of Bulletins Nos. 1 to 35 are already published, viz:

1. On Hypersthene-Andesite and on Triclinic Pyroxene in Augitic Rocks, by Whitman Cross, with a Geological Sketch of Buffalo Peaks, Colorado, by S. F. Emmons. 1883. 8°. 42 pp. 2 pl. Price 10 cents.

2. Gold and Silver Conversion Tables, giving the coining values of troy ounces of fine metal, etc., by Albert Williams, jr. 1883. 8°. 8 pp. Price 5 cents.

3. On the Fossil Faunas of the Upper Devonian, along the meridian of 76° 30′, from Tompkins County, New York, to Bradford County, Pennsylvania, by Henry S. Williams. 1884. 8°. 36 pp. Price 5 cents.

4. On Mesozoic Fossils, by Charles A. White. 1884. 8°. 36 pp. 9 pl. Price 5 cents.

5. A Dictionary of Altitudes in the United States, compiled by Henry Gannett. 1884. 8°. 325 pp. Price 20 cents.

6. Elevations in the Dominion of Canada, by J. W. Spencer. 1884. 8°. 43 pp. Price 5 cents.

7. Mapoteca Geologica Americana. A catalogue of geological maps of America (North and South), 1752–1881, by Jules Marcou and John Belknap Marcou. 1884. 8°. 184 pp. Price 10 cents.

8. On Secondary Enlargements of Mineral Fragments in Certain Rocks, by R. D. Irving and C. R. Van Hise. 1884. 8°. 56 pp. 6 pl. Price 10 cents.

9. Report of work done in the Washington Laboratory during the fiscal year 1883–'84. F. W. Clarke, chief chemist; T. M. Chatard, assistant. 1884. 8°. 40 pp. Price 5 cents.

10. On the Cambrian Faunas of North America. Preliminary studies, by Charles D. Walcott. 1884. 8°. 74 pp. 10 pl. Price 5 cents.

11. On the Quaternary and Recent Mollusca of the Great Basin; with Descriptions of New Forms, by R. Ellsworth Call; introduced by a sketch of the Quaternary Lakes of the Great Basin, by G. K. Gilbert. 1884. 8°. 66 pp. 6 pl. Price 5 cents.

12. A Crystallographic Study of the Thinolite of Lake Lahontan, by Edward S. Dana. 1884. 8°. 34 pp. 3 pl. Price 5 cents.

13. Boundaries of the United States and of the several States and Territories, by Henry Gannett. 1885. 8°. 135 pp. Price 10 cents.

14. The Electrical and Magnetic Properties of the Iron-Carburets, by Carl Barus and Vincent Strouhal. 1885. 8°. 238 pp. Price 15 cents.

15. On the Mesozoic and Cenozoic Paleontology of California, by Charles A. White. 1885. 8°. 33 pp. Price 5 cents.

16. On the higher Devonian Faunas of Ontario County, New York, by John M. Clarke. 1885. 8°. 86 pp. 3 pl. Price 5 cents.

17. On the Development of Crystallization in the Igneous Rocks of Washoe, Nevada, by Arnold Hague and Joseph P. Iddings. 1885. 8°. 44 pp. Price 5 cents.

18. On Marine Eocene, Fresh-water Miocene, and other Fossil Mollusca of Western North America, by Charles A. White. 1885. 8°. 26 pp. 3 pl. Price 5 cents.

19. Notes on the Stratigraphy of California, by George F. Becker. 1885. 8°. 28 pp. Price 5 cents.

20. Contributions to the Mineralogy of the Rocky Mountains, by Whitman Cross and W. F. Hillebrand. 1885. 8°. 114 pp. 1 pl. Price 10 cents.

21. The Lignites of the Great Sioux Reservation, by Bailey Willis. 1885. 8°. 16 pp. 5 pl. Price 5 cents.

22. On New Cretaceous Fossils from California, by Charles A. White. 1885. 8°. 25 pp. 5 pl. Price 5 cents.

23. Observations on the Junction between the Eastern Sandstone and the Keweenaw Series on Keweenaw Point, Lake Superior, by R. D. Irving and T. C. Chamberlin. 1885. 8°. 124 pp. 17 pl. Price 15 cents.

24. List of Marine Mollusca, comprising the Quaternary fossils and recent forms from American localities between Cape Hatteras and Cape Roque, including the Bermudas, by William H. Dall. 1885. 8°. 336 pp. Price 25 cents.

25. The Present Technical Condition of the Steel Industry of the United States, by Phineas Barnes. 1885. 8°. 85 pp. Price 10 cents.

26. Copper Smelting, by Henry M. Howe. 1885. 8°. 107 pp. Price 10 cents.

27. Report of work done in the division of Chemistry and Physics, mainly during the fiscal year 1884–'85. 1886. 8°. 80 pp. Price 10 cents.

28. The Gabbros and Associated Hornblende Rocks occurring in the neighborhood of Baltimore, Md., by George H. Williams. 1886. 8°. 78 pp. 4 pl. Price 10 cents.

29. On the Fresh-water Invertebrates of the North American Jurassic, by Charles A. White. 1886. 8°. 41 pp. 4 pl. Price 5 cents.

30. Second contribution to the studies on the Cambrian Faunas of North America, by Charles D. Walcott. 1886. 8°. 369 pp. 33 pl. Price 25 cents.

31. A systematic review of our present knowledge of Fossil Insects, including Myriapods and Arachnids, by Samuel H. Scudder. 1886. 8°. 128 pp. Price 15 cents.

32. Mineral Springs of the United States, by Albert C. Peale. 1886. 8°. 235 pp. Price 20 cents.

33. Notes on the Geology of Northern California, by Joseph S. Diller. 1886. 8°. 23 pp. Price 5 cents.

34. On the relation of the Laramie Molluscan Fauna to that of the succeeding Fresh-water Eocene and other groups, by Charles A. White. 1886. 8°. 54 pp. 5 pl. Price 10 cents.

35. The Physical Properties of the Iron-Carburets, by Carl Barus and Vincent Strouhal. 1886. 8°. 62 pp. Price 10 cents.

Numbers 1 to 6 of the Bulletins form Volume I; Numbers 7 to 14, Volume II; Numbers 15 to 23, Volume III; Numbers 24 to 30, Volume IV. Volume V is not yet complete.

The following are in press, viz:

36. The Subsidence of small particles of Insoluble Solid in Liquid, by Carl Barus.

37. Types of the Laramie Flora, by Lester F. Ward.

38. Peridotite of Elliott County Kentucky, by Joseph S. Diller.

39. The Upper Beaches and Deltas of the Glacial Lake Agassiz, by Warren Upham.

In preparation:

40. Geologic notes in Northern Washington Territory, by Bailey Willis.

41. Fossil Faunas of the Upper Devonian—the Genesee Section, by Henry S. Williams.

42. Report of work done in the division of Chemistry and Physics, mainly during the fiscal year 1885–'86. F. W. Clarke, chief chemist.

43. On the Tertiary and Cretaceous Strata of the Tuscaloosa, Tombigbee, and Alabama Rivers, by Eugene A. Smith and Lawrence C. Johnson.

44. Historic statement respecting geologic work in Texas, by R. T. Hill.

45. The Nature and Origin of Deposits of Phosphates of Lime, by R. A. F. Penrose, jr.

46. Bibliography of North American Crustacea, by A. W. Vogdes.

## STATISTICAL PAPERS.

A fourth series of publications, having special reference to the mineral resources of the United States, has been undertaken.

Of that series the following have been published, viz:

Mineral Resources of the United States [1882], by Albert Williams, jr. 1883. 8°. xvii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1883 and 1884, by Albert Williams, jr. 1885. 8°. xiv, 1016 pp. Price 60 cents.

Mineral Resources of the United States, 1885. Division of Mining Statistics and Technology. 1886. 8°. vii, 576 pp. Price 40 cents.

Correspondence relating to the publications of the Survey, and all remittances, which must be by POSTAL NOTE or MONEY ORDER (not stamps), should be addressed

TO THE DIRECTOR OF THE
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

WASHINGTON, D. C., *January* 1, 1887.

# NOTICE.

This volume, "Mineral Resources of the United States, 1885," is the third of a series which began in 1882. It can be obtained for 40 cents. The first volume is entitled "Mineral Resources of the United States, 1882." It is sold for 50 cents. The second volume is called "Mineral Resources of the United States, 1883 and 1884," and is sold for 60 cents. Remittances should be made by postal note (not stamps), and should be addressed to the Director United States Geological Survey, Washington, D. C. In ordering the different volumes of this series care should be taken to designate the first as "Mineral Resources, 1882," the second as "Mineral Resources, 1883 and 1884," and this volume as "Mineral Resources, 1885."

Corrections, additions, or notice of important omissions, reports and maps of mines and mining districts, pamphlets on metallurgical processes, brief notes on new mineral localities, etc., will be highly appreciated, and should be addressed to David T. Day, U. S. Geological Survey, Washington, D. C. Duplicate copies of such reports, etc., are especially desired for extending the fine set of mining pamphlets in the library of the Survey, and will be thankfully acknowledged if sent to the

DIRECTOR OF THE
UNITED STATES GEOLOGICAL SURVEY,
*Washington, D. C.*

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
J. W. POWELL, DIRECTOR

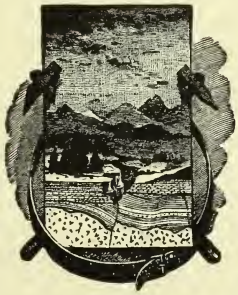
# MINERAL RESOURCES

OF THE

# UNITED STATES

## CALENDAR YEAR 1885

DIVISION OF MINING STATISTICS AND TECHNOLOGY



WASHINGTON
GOVERNMENT PRINTING OFFICE
1886

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# LETTER OF TRANSMITTAL.

UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF MINING STATISTICS AND TECHNOLOGY,
*Washington, D. C., September* 15, 1886.

SIR: I have the honor to transmit herewith a statistical report upon the present condition of the mining industries of the United States. The statistical canvass for the report was arranged and conducted by Mr. Albert Williams, jr., who remained in charge of this division until the material was nearly ready for printing. Mr. Williams has also given valuable aid in the final revision. This report is the third of the series entitled "Mineral Resources of the United States." The first volume contained the statistics for 1882 and the first six months of 1883; in the second, the statistics were carried to December 31, 1884; and the present volume deals with the changes in the mineral industries during the calendar year 1885. In accordance with your instructions it is proposed to issue a fourth report, for the calendar year 1886, early in 1887.

Very respectfully, your obedient servant,

DAVID T. DAY,
*Geologist in Charge.*

Hon. J. W. POWELL,
*Director United States Geological Survey.*

# INTRODUCTORY.

*Object of the report.*—The present volume is the third of a series designed to present the principal statistics concerning the mineral products of the United States, together with such descriptive matter as will throw light upon the condition of the industries which these products materially affect, or will aid in utilizing material which has no value at present. In the first volume the state of the mineral industries was presented as it appeared in 1882, and the statistics were extended through the first six months of the calendar year 1883. The second volume carried the statistics to December 31, 1884, and gave the changes during the calendar years 1883 and 1884, together with information supplementary to the first volume. The present report deals with the changes in 1885, and carries the statistics to December 31 of that year. The repetition of all matter except statistical tables is avoided wherever possible, hence the three reports should be consulted together. The omission from the present report of certain subjects which have been treated in the former volumes may be taken as indicating that the changes are slight in so far as information has been obtainable by this office.

*Acknowledgments.*—It is impossible to mention even the names of all the persons who have freely given valuable assistance, often at a great sacrifice of time and labor, in the compilation of a report embracing statistics from so large a territory. In any importmant chapters of the book the contributions have been obtained from experts whose entire attention has been given for years to the study of the subjects under which their names appear; and hence these articles contain more valuable and extended information than could otherwise have been secured. It is gratifying to testify to the general courtesy and hearty co-operation of the manufacturers and dealers in responding to the numerous requests for information.

*Delay in publication.*—It is recognized that the value of statistical information depends largely upon promptness in publication. This has, however, been partly sacrificed in order to make use of every available aid towards accuracy, particularly with subjects like coal, where the information must be sought from very many sources. Delay in a single subject thus extends to the whole report. Advance sheets of the important subjects have been published, however, as soon as the information was complete. All the matter in the book, moreover, has been

subjected to revision much later than the end of the period treated. The delay in printing and binding has been much less than could reasonably have been expected in a season of great pressure at the Government Printing Office.

*The period included in the report* is the calendar year 1885. The tables of production are made to conform to this period except where information is only obtainable for other divisions of time, as in the reports of imports and exports furnished for fiscal years by the Bureau of Statistics, and in a few industries where the seasons of production or manufacture make more actual divisions. Thus the manufacture of artificial fertilizers has been given from May 1 to April 30, because the most active season would be divided at December 31.

*The methods of statistical inquiry.*—A canvass of the United States for precise returns has been made concerning some of the industries; with others this is impossible within a period consistent with valuable statistics, unless made at a disproportionate expenditure of money. The composition of aggregates by such a system is also open to serious danger when the returns are withheld from a single point of production. The estimates of authorities are therefore of more practical value where the detailed canvass would be too complicated, provided these estimates are checked by actual returns from all available sources. Both of these systems are used in this report with results which are by no means uniform in their accuracy. They simply represent the best figures attainable. Fortunately the greater the industrial importance of a mineral the greater are usually the facilities for determining its output. With some substances, such as copper and pig iron, the production can be given to within a small fraction of a per cent. In other cases the widely scattered points of production make this impossible, and the statement of an exact figure of production would then imply a co-operation among the producers which frequently does not yet exist. As a matter of fact, a large proportion of the results are direct returns.

# MINERAL RESOURCES OF THE UNITED STATES.

CALENDAR YEAR 1885.

*Division of Mining Statistics and Technology.*

## SUMMARY—1885.

*Coal.*—The total commercial product of coal of all kinds in 1885, exclusive of that consumed at the mines, known as colliery consumption, was 95,834,705 long tons, valued at $152,915,108. Of this 32,265,421 long tons were Pennsylvania anthracite, valued at $72,274,544; while of other coals, including bituminous, brown coal, lignite, and small lots of anthracite produced outside of Pennsylvania, the production was 63,569,284 long tons, valued at $80,640,564 at the points of production. The total production including colliery consumption was: Pennsylvania anthracite 34,228,548 long tons, all other coals 64,840,668 long tons, making the total absolute production of the coal mines of the United States 99,069,216 long tons, valued as follows: Anthracite, $76,671,948; bituminous, $82,347,648; total, $159,019,596. The total production (including local consumption) of anthracite was 1,052,792 tons in excess of that of 1884, and its value was $10,320,436 greater. The total production of bituminous coal was 8,889,871 tons less than in 1884, but its value was $4,930,582 greater. The total production of coal of all kinds shows a net loss in tonnage of 7,837,079 long tons compared with that of 1884, but a gain in value of $15,251,018, the increase in value being due to an average increase of 25 cents per long ton. The total value is about the same as that of 1883.

*Coke.*—The total production of coke in 1885 was 5,106,696 short tons, valued at the ovens at $7,629,118. Of this Pennsylvania produced 78 per cent., or 3,991,805 tons, valued at $4,981,656. The remainder was produced by fourteen States and Territories. The maximum production of coke in the United States was reached in 1883, when 5,464,721 tons were made. This declined in 1884 to 4,873,805 tons. The production of 1885 shows a gain upon that of 1884, being within 360,000 tons of the make in 1883.

*Petroleum.*—The total production was 21,842,041 barrels of 42 gallons, of which the Pennsylvania and New York fields produced 20,776,041 barrels. The total value, at an average price of 87⅞ cents per barrel, was $19,193,694. The production showed a decrease of 2,247,717 barrels and $1,282,600 in value from 1884.

*Natural gas.*—No record is kept of the yield in cubic feet. The amount of coal displaced by gas in 1885, was 3,161,600 tons, valued at $4,854,200. In 1884 the coal displaced was valued at $1,460,000. The yield has increased tenfold since 1883.

*Iron.*—The principal statistics for 1885 were: Domestic iron ore consumed, 7,600,000 long tons; value at mine $19,000,000. Imported iron ore consumed, 390,786 long tons; total iron ore consumed, 7,990,786 long tons; pig iron made, 4,044,525 long tons, a decrease of 53,343 tons as compared with 1884; value at furnace $64,712,400, or $9,049,224 less than in 1884. Total spot value of all iron and steel in the first stage of of manufacture, excluding all duplications, $93,000,000 a decline of $14,000,000 from 1884.

*Gold and silver.*—The mint authorities estimate the value of the gold produced in 1885 at $31,801,000, an increase of $1,001,000 over 1884. The production of silver is similarly estimated at $51,600,000, an increase of $2,800,000 over 1884.

*Copper.*—The production in 1885, including 5,086,841 pounds made from imported pyrites, was 170,962,607 pounds, valued in New York at $18,292,999 at the average price of 10.7 cents per pound. The increase in pounds over 1884 was 23,157,200; in value $186,337.

*Lead.*—Production, 129,412 short tons. Total value, at an average price of $81 per short ton at the Atlantic coast, $10,469,431, a decline of 10,485 tons and $67,611 in value from the product of 1884. The production of white lead is estimated at 60,000 short tons, worth at 5¼ cents per pound, $6,300,000.

*Zinc.*—The production of metallic zinc in 1885 was 40,688 short tons, valued at $3,539,856 at an average value of 4.35 cents per pound, an increase of 2,144 tons and $117,149 in value over 1884. Zinc was also made from the ore directly into zinc white (zinc oxide) to the extent of 15,000 short tons, valued at $1,050,000.

*Quicksilver.*—Production, 32,073 flasks (of 76½ pounds net), or 160 flasks more than in 1884. Total value, at an average price of $30.53 per flask at San Francisco, $979,189, an increase of $42,862 over 1884. The production of quicksilver vermilion was about 600,000 pounds, the same as in 1884, but the price advanced to 52 cents per pound, making the total value $312,000.

*Nickel.*—The production of metallic or "grain" nickel was 245,504 pounds, valued at $169,397. In addition, matte and ore containing 32,400 pounds of nickel were exported. Total value of all nickel, $191,753.

*Cobalt.*—The amount of cobalt oxide was 8,423 pounds, valued at $19,373. The total value of cobalt in ore, matte, and the above oxide was $65,373.

*Manganese.*—The production of manganese ores was 23,258 long tons, valued at $190,281. Manganiferous iron ore, 3,237 long tons, valued at $17,318. Total value, $207,599.

*Chromium.*—The production of chrome iron ore was 2,700 long tons, valued at $40,000. The consumption for making potassium and sodium bichromates increased markedly, due to imports of chrome iron ore from Asia Minor.

*Tin.*—Probably 200 tons of "black tin" ore were made at the concentrating works at the Etta mine in Dakota. No smelting works have yet been erected.

*Platinum.*—The amount of crude platinum mined in 1885 was about 250 troy ounces, valued at $187. This is exclusive of about 300 ounces of iridosmine, for pointing pens.

*Aluminum.*—The production of metallic aluminum increased from 1,800 troy ounces in 1884 to 3,400 ounces in 1885, valued at $2,550. Aluminum bronze, containing 10 per cent. aluminum, was made to the amount of about 4,500 pounds, valued at $1,800.

*Building stone.*—Value, $19,000,000; about the same as in 1884.

*Brick and tile.*—The demand and consequent production increased to an estimated value of $35,000,000 in 1885.

*Lime.*—With the price constant at 50 cents per barrel at the kilns, the production increased from 37,000,000 barrels in 1884 to 40,000,000 in 1885.

*Cement.*—The production of cement from natural rock increased to 4,000,000 barrels of 300 pounds each, but was valued at only $3,200,000. Artificial Portland cement amounted to 150,000 barrels of 400 pounds each, with a total value of $292,500. The total production of cement of all kinds was 4,150,000 barrels, valued at $3,492,500, against $3,720,000 in 1884.

*Precious stones.*—The value of American precious stones produced in 1885 was $69,900. This includes $42,800 for stones sold as specimens and souvenirs and $27,100 for stones to be cut into gems. Besides this, gold quartz, with an estimated value of $140,000 was sold for specimens and for ornaments and jewelry.

*Millstones.*—The trade in millstones of all kinds has decreased markedly from the introduction of roller mills. The total value of the Esopus millstones in New York and Cocalico stone in Pennsylvania did not exceed $100,000 in 1885.

*Grindstones.*—Estimated value of product for 1885, $500,000.

*Phosphates.*—With the exception of a local consumption of about 1,000 tons in North Carolina, the total production of phosphate rock came from South Carolina, and amounted to 437,856 long tons of washed

rock for the calendar year 1885, valued at $2,846,064, at an average value of $6.50 per ton.

*Gypsum.*—The estimated production of land plaster in 1885 was 100,600 short tons; of calcined plaster 72,200 tons; total 172,800 tons, valued at $959,600. The above includes 75,100 tons from native stone, the remainder being imported from Nova Scotia.

*Salt.*—The total production in barrels of 280 pounds was 7,038,653, exceeding the yield of 1884 by 523,716 barrels. The total value of all salt produced was $4,825,345, an increase of $732,887, which was due partly to the increased value of the Michigan product, and partly to the large increase in the production of western New York.

*Bromine.*—The production increased slightly, being about 310,000 pounds against 281,100 in 1884. The total value, at an average of 29 cents per pound, was $89,900, an increase of $22,436 above the previous year.

*Borax.*—Production, limited to California and Nevada, 8,000,000 pounds; value, at 6 cents per pound for concentrated, $480,000. While the product increased by 1,000,000, the fall in price lowered the total value by $10,000.

*Sulphur.*—The production was only about 700 tons, worth about $18,000.

*Pyrites.*—About 49,000 long tons were mined, valued at $220,500. In addition 47,500 tons were imported.

*Barytes.*—The production was about 15,000 tons, valued at $75,000, in the unground condition, as taken from the mines.

*Mica.*—The production decreased in the West, owing to the inferior value of the sheets obtained. The whole product, excluding waste, was 92,000 pounds, valued at $161,000.

*Feldspar.*—Production, 13,600 long tons, valued, before grinding, at $68,000.

*Asbestus.*—The amount mined was about 300 short tons, valued at $9,000.

*Asphaltum.*—The production remained constant at about 3,000 tons, with a spot value of $10,500.

*Mineral waters.*—The sales amounted to $1,312,845, from 9,148,401 gallons; the value is slightly less than in 1884. The great change in the number of gallons stated in the last report is due to the exclusion of the water from artesian wells in Madison, Wisconsin, which is used as the regular city supply. A large local consumption is also excluded.

*Totals.*—The statements made in the last report in regard to the total mineral product require little change for the year 1885. The statistics have been compiled with a view to giving information on those points which are of most interest and utility, and are presented in the form usual in the several branches of trade statistics. Comparing the totals given since 1882, a continuous decrease in value is noted in 1883 and

1884, being marked in the latter year. The year 1885 shows, on the other hand, an increase, due, no doubt, in part to more complete returns and closer estimates, but indicating, nevertheless, a more profitable business year, which would be still more apparent if the last half were compared with the corresponding period in 1884, since, in many important branches of trade, prices increased towards the end of the year.

*Metallic products of the United States in* 1885.

| | Quantity. | Value. |
|---|---|---|
| Pig-iron, spot value ..... long tons.. | 4,044,525 | $64,712,400 |
| Silver, coining value ..... troy ounces.. | 39,910,279 | 51,600,000 |
| Gold, coining value ..... do.... | 1,538,376 | 31,801,000 |
| Copper, value at New York City (*a*) ..... pounds.. | 170,962,607 | 18,292,999 |
| Lead, value at New York City ..... short tons.. | 129,412 | 10,469,431 |
| Zinc, value at New York City ..... do.... | 40,688 | 3,539,856 |
| Quicksilver, value at San Francisco ..... flasks.. | 32,073 | 979,189 |
| Nickel, value at Philadelphia ..... pounds.. | 277,904 | 191,753 |
| Aluminum, value at Philadelphia ..... troy ounces.. | 3,400 | 2,550 |
| Platinum, value, crude, at New York City ..... do.... | 250 | 187 |
| Total ..... | ..... | $181,589,365 |

*a* Including copper from imported pyrites.

*Non-metallic mineral products of the United States in* 1885 (*spot values*).

| | Quantity. | Value. |
|---|---|---|
| Bituminous coal, brown coal, lignite, and anthracite, mined elsewhere than in Pennsylvania ..... long tons (*a*). | 64,840,668 | $82,347,648 |
| Pennsylvania anthracite ..... do (*b*). | 34,228,548 | 76,671,948 |
| Petroleum ..... barrels.. | 21,842,041 | 19,193,694 |
| Building stone ..... | ..... | 19,000,000 |
| Lime ..... barrels.. | 40,000,000 | 20,000,000 |
| Salt ..... do.... | 7,038,653 | 4,825,345 |
| Cement ..... do.... | 4,150,000 | 3,492,500 |
| South Carolina phosphate rock ..... long tons.. | 437,856 | 2,846,064 |
| Limestone for iron flux ..... | ..... | 1,694,656 |
| Mineral waters ..... gallons sold.. | 9,148,401 | 1,312,845 |
| Natural gas ..... | ..... | 4,854,200 |
| Zinc, white ..... short tons.. | 15,000 | 1,050,000 |
| Concentrated borax ..... pounds.. | 8,000,000 | 480,000 |
| New Jersey marls ..... short tons.. | 875,000 | 437,500 |
| Mica ..... pounds.. | 92,000 | 161,000 |
| Pyrites ..... long tons.. | 49,600 | 220,500 |
| Gold quartz souvenirs, jewelry, &c ..... | ..... | 140,000 |
| Manganese ore ..... long tons.. | 23,258 | 190,281 |

*a* The commercial product, that is, the amount marketed, was only 63,569,284 tons, valued at $80,640,564.

*b* The commercial product, that is, the amount marketed, was only 32,265,421 tons, valued at $72,274,544.

*Non-metallic mineral products of the United States in* 1885 (*spot value*), *&c.*—Continued.

| | Quantity. | Value. |
|---|---|---|
| Crude barytes ..... long tons.. | 15,000 | 75,000 |
| Ocher ..... do.... | 3,950 | 43,575 |
| Precious stones ..... | ..... | 69,900 |
| Bromine ..... pounds.. | 310,000 | 89,900 |
| Feldspar ..... long tons.. | 13,600 | 68,000 |
| Chrome iron ore ..... do .. | 2,700 | 40,000 |
| Asbestus ..... short tons.. | 300 | 9,000 |
| Slate ground as a pigment ..... long tons.. | 1,975 | 24,687 |
| Sulphur ..... short tons.. | 715 | 17,875 |
| Asphaltum ..... do.... | 3,000 | 10,500 |
| Cobalt oxide ..... pounds.. | 68,723 | 65,373 |
| Total ..... | ..... | $239,431,991 |

*Résumé of the values of the metallic and non-metallic mineral substances produced in the United States in* 1885.

| | |
|---|---|
| Metals ..... | $181,589,365 |
| Mineral substances named in the foregoing table ..... | 239,431,991 |
| | $421,021,356 |
| Estimated value of mineral products unspecified ..... | 7,500,000 |
| Grand total ..... | $428,521,356 |

*Summary of the mineral products of the United States, calendar years* 1882, 1883, 1884, *and* 1885.

| Products. | 1882. | | 1883. | | 1884. | | 1885. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| METALLIC. | | | | | | | | |
| Pig-iron, spot value ..... long tons.. | 4,623,323 | $106,336,429 | 4,595,510 | $91,910,200 | 4,097,868 | $73,761,624 | 4,044,525 | $64,712,400 |
| Silver, coining value ..... troy ounces.. | 36,197,695 | 46,800,000 | 35,733,622 | 46,200,000 | 37,744,605 | 48,800,000 | 39,910,279 | 51,600,000 |
| Gold, coining value ..... do..... | 1,572,186 | 32,500,000 | 1,451,249 | 30,000,000 | 1,489,949 | 30,800,000 | 1,538,376 | 31,801,000 |
| Copper, value at New York City ..... pounds.. | 91,646,232 | 16,038,091 | 117,151,795 | 18,064,807 | 147,805,407 | 18,106,162 | 170,962,607 | 18,292,999 |
| Lead, value at New York City ..... short tons.. | 132,890 | 12,624,550 | 143,957 | 12,322,719 | 139,897 | 10,537,042 | 129,412 | 10,469,431 |
| Zinc, value at New York City ..... do.... | 33,765 | 3,646,620 | 36,872 | 3,311,106 | 38,544 | 3,422,707 | 40,688 | 3,539,856 |
| Quicksilver, value at San Francisco ..... flasks.. | 52,732 | 1,487,042 | 46,725 | 1,253,632 | 31,913 | 936,327 | 32,073 | 979,189 |
| Nickel, value at Philadelphia ..... pounds.. | 281,616 | 309,777 | 58,800 | 52,920 | 64,550 | 48,412 | 277,904 | 191,753 |
| Antimony, value at San Francisco ..... short tons.. | 60 | 12,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Platinum, value (crude) at New York City ... troy ounces.. | 200 | 600 | 200 | 600 | 150 | 450 | 250 | 187 |
| Aluminum, value at Philadelphia ..... troy ounces.. | ..... | ..... | 1,000 | 875 | 1,800 | 1,350 | 3,400 | 2,550 |
| Total value metallic products ..... | ..... | 219,755,109 | ..... | 203,116,859 | ..... | 186,414,074 | ..... | 181,589,365 |

*Summary of the mineral products of the United States, &c.*—Continued.

| Products. | 1882. | | 1883. | | 1884. | | 1885. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| NON-METALLIC (SPOT VALUES). | | | | | | | | |
| Bituminous coal ..... long tons.. | 60,861,190 | $76,076,487 | 68,531,500 | $82,237,800 | 73,730,539 | $77,417,066 | 64,840,668 | $82,347,648 |
| Pennsylvania anthracite ..... do .... | 31,358,264 | 70,556,094 | 34,336,469 | 77,257,055 | 33,175,756 | 66,351,512 | 34,228,548 | 76,671,948 |
| Petroleum ..... barrels.. | 30,053,500 | 23,704,698 | 23,400,229 | 25,740,252 | 24,089,758 | 20,476,294 | 21,842,041 | 19,193,694 |
| Lime ..... do.... | 31,000,000 | 21,700,000 | 32,000,000 | 19,200,000 | 37,000,000 | 18,500,000 | 40,000,000 | 20,000,000 |
| Building stone ..... | ..... | 21,000,000 | ..... | 20,000,000 | ..... | 19,000,000 | ..... | 19,000,000 |
| Salt ..... barrels.. | 6,412,373 | 4,340,140 | 6,192,231 | 4,211,042 | 6,514,937 | 4,197,734 | 7,038,653 | 4,825,345 |
| Cement ..... do.... | 3,250,000 | 3,672,750 | 4,190,000 | 4,293,500 | 4,000,000 | 3,720,000 | 4,150,000 | 3,492,500 |
| Limestone for iron flux ..... long tons. | 3,850,000 | 2,310,000 | 3,814,273 | 1,907,136 | 3,401,930 | 1,700,965 | ..... | 1,694,656 |
| South Carolina phosphate rock ..... do.... | 332,077 | 1,992,462 | 378,380 | 2,270,280 | 431,779 | 2,374,784 | 437,856 | 2,846,064 |
| New Jersey marls ..... short tons.. | 1,080,000 | 540,000 | 972,000 | 486,000 | 875,000 | 437,500 | 875,000 | 437,500 |
| Borax ..... pounds.. | 4,236,291 | 338,903 | 6,500,000 | 585,000 | 7,000,000 | 490,000 | 8,000,000 | 480,000 |
| Mica ..... do.... | 100,000 | 250,000 | 114,000 | 285,000 | 147,410 | 368,525 | 92,000 | 161,000 |
| Ocher ..... long tons.. | 7,000 | 105,000 | 7,000 | 84,000 | 7,000 | 84,000 | 3,950 | 43,575 |
| Soapstone ..... short tons.. | 6,000 | 90,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Crude barytes ..... long tons.. | 20,000 | 80,000 | 27,000 | 108,000 | 25,000 | 100,000 | 15,000 | 75,000 |
| Precious stones ..... | ..... | 75,000 | ..... | 74,050 | ..... | 82,975 | ..... | 69,900 |
| Gold-quartz souvenirs, jewelry, etc ..... | ..... | 75,000 | ..... | 115,000 | ..... | 140,000 | ..... | 140,000 |
| Pyrites ..... long tons.. | 12,000 | 72,000 | 25,000 | 137,500 | 35,000 | 175,000 | 49,000 | 220,500 |
| Manganese ore ..... do.... | 3,500 | 52,500 | 8,000 | 120,000 | 10,000 | 120,000 | 23,258 | 190,281 |
| Chrome iron ore ..... do.... | 2,500 | 50,000 | 3,000 | 60,000 | 2,000 | 35,000 | 2,700 | 40,000 |
| Asbestus ..... short tons.. | 1,200 | 36,000 | 1,000 | 30,000 | 1,000 | 30,000 | 300 | 9,000 |
| Graphite ..... pounds.. | 425,000 | 34,000 | 575,000 | 46,000 | ..... | ..... | ..... | ..... |
| Cobalt oxide ..... do.... | 11,653 | 32,046 | 1,096 | 2,795 | 2,000 | 5,100 | 68,723 | 65,373 |
| Slate ground as a pigment ..... long tons.. | 2,000 | 24,000 | 2,000 | 24,000 | 2,000 | 20,000 | 1,975 | 24,687 |
| Sulphur ..... short tons.. | 600 | 21,000 | 1,000 | 27,000 | 500 | 12,000 | 715 | 17,875 |
| Asphaltum ..... do.... | 3,000 | 10,500 | 3,000 | 10,500 | 3,000 | 10,500 | 3,000 | 10,500 |
| Corundum ..... do.... | 500 | 6,250 | ..... | ..... | ..... | ..... | ..... | ..... |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pumice-stone ..... do.... | 70 | 1,750 | ..... | ..... | ..... | ..... | ..... | ..... |
| Feldspar ..... long tons.. | ..... | ..... | 14,100 | 71,112 | 10,900 | 55,112 | 13,600 | 68,000 |
| Zinc-white ..... short tons.. | ..... | ..... | ..... | ..... | 13,000 | 910,000 | 15,000 | 1,050,000 |
| Bromine ..... pounds.. | ..... | ..... | 301,100 | 72,264 | 281,100 | 67,464 | 310,000 | 89,900 |
| Mineral waters ..... gallons sold.. | ..... | ..... | 7,529,423 | 1,119,603 | 10,215,328 | 1,459,143 | 9,148,401 | 1,312,845 |
| Natural gas ..... | ..... | 215,000 | ..... | 475,000 | ..... | 1,460,000 | ..... | 4,854,200 |
| Total value non-metallic mineral products ..... | ..... | $227,461,580 | ..... | $241,049,889 | ..... | $219,800,674 | ..... | $239,431,991 |
| Total value metallic products ..... | ..... | 219,755,109 | ..... | 203,116,859 | ..... | 186,414,074 | ..... | 181,589,365 |
| Estimated value of mineral products unspecified ..... | ..... | 8,000,000 | ..... | 8,000,000 | ..... | 7,000,000 | ..... | 7,500,000 |
| Grand total ..... | ..... | $455,216,689 | ..... | $452,166,748 | ..... | $413,214,748 | ..... | $428,521,356 |

# COAL.

By Charles A. Ashburner.

The coal statistics for 1885 have been compiled from various sources. The report on the anthracite region of Pennsylvania has been furnished by the geologist in charge of the State survey; those from Colorado, Dakota, Montana, New Mexico and Wyoming, by Mr. F. F. Chisolm, and those for the Pacific coast States, by Mr. C. G. Yale. In most other cases the reports have been compiled from data furnished by the different State mine inspectors, or by the State authorities, credit being given in each case.

## PRODUCTION.

The statistics of the following regions are reported in long tons of 2,240 pounds: Pennsylvania anthracite region, Virginia, West Virginia, Maryland, Iowa, Kentucky, Alabama, Michigan, and Missouri. In all other regions the statistics are reported in short tons of 2,000 pounds. The former tonnage unit is the one most generally used, and the total production of each State where it is given in short tons, in the special report, has been reduced to long tons for the table showing the summary for the United States. The commercial product, exclusive of that which is consumed at the mines, known as colliery consumption, during 1885 was: Pennsylvania anthracite, 36,137,272, short, or 32,265,421 long tons, the market value of which has been estimated to have been $72,274,544; bituminous, brown coal, lignite, and small lots of anthracite, mined in Colorado and Arkansas, 71,195,358 short, or 63,567,284 long tons, the market value of which has been estimated to have been $80,640,724, making a total production of 107,332,629 short, or 95,832,705 long tons, valued at $152,915,268. The total production, including colliery consumption, was Pennsylvania anthracite 38,335,973 short, or 34,228,548 long tons, all other coals 72,621,549 short, or 64,840,668 long tons, making the total absolute production of the coal mines of the United States for the year 110,957,522 short, or 99,069,216 long tons.

The following table shows the commercial output in long tons of the States and Territories, from 1881 to 1885 inclusive. In the case of a few of the small items, originally estimated in short tons, it has not been thought advisable to convert the figures into long tons, the difference being less than the probable error, and the round numbers being con-

sidered preferable. In addition the table shows the estimated value at the mines of the commercial coal produced in each State or Territory, in 1885.

*Coal produced in the several States and Territories, not including the local and colliery consumption, and the value of the mines in* 1885.

| States and Territories. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | Value of coal at mines, 1885. |
|---|---|---|---|---|---|---|---|
| Pennsylvania: | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | |
| Anthracite | 23,437,242 | 28,500,016 | 29,120,096 | 31,793,027 | 30,718,293 | 32,265,421 | $72,274,544 |
| Bituminous | 19,000,000 | 20,000,000 | 22,000,000 | 24,000,000 | 25,000,000 | 23,214,285 | 24,700,000 |
| Illinois | 4,000,000 | 6,000,000 | 9,000,000 | 10,350,000 | 10,000,000 | 8,742,745 | 11,456,493 |
| Ohio | 7,000,000 | 8,250,000 | 9,450,000 | 8,229,429 | 7,650,062 | 6,978,732 | 8,206,988 |
| Maryland | 2,136,160 | 2,261,918 | 1,540,466 | 2,206,172 | 2,469,051 | 2,865,974 | 3,209,891 |
| Missouri | 1,500,000 | 1,750,000 | 2,000,000 | 2,250,000 | 2,500,000 | 2,750,000 | 3,850,000 |
| West Virginia | 1,400,000 | 1,500,000 | 2,000,000 | 2,805,565 | 3,000,000 | 3,008,091 | 3,369,062 |
| Indiana | 1,500,000 | 1,771,536 | 1,976,470 | 2,560,000 | 2,260,000 | 2,120,535 | 2,731,250 |
| Iowa | 1,600,000 | 3,500,000 | 3,127,700 | 3,881,300 | 3,903,458 | 3,583,737 | 4,819,230 |
| Kentucky | 1,000,000 | 1,100,000 | 1,300,000 | 1,650,000 | 1,550,000 | 1,700,000 | 2,094,400 |
| Tennessee | 600,000 | 750,000 | 850,000 | 1,000,000 | 1,200,000 | 892,857 | 1,100,000 |
| Virginia | 100,000 | 100,000 | 100,000 | 225,000 | 300,000 | 567,000 | 666,792 |
| Kansas | 550,000 | 750,000 | 750,000 | 900,000 | 1,100,000 | 1,082,230 | 1,410,438 |
| Michigan | 75,000 | 100,000 | 130,000 | 135,000 | 135,000 | 45,178 | 75,000 |
| Rhode Island | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | ..... | ..... |
| Alabama | 340,000 | 375,000 | 800,000 | 1,400,000 | 2,000,000 | 2,225,000 | 2,990,000 |
| Georgia | 100,000 | 150,000 | 175,000 | 200,000 | 200,000 | 133,929 | 189,000 |
| Colorado | 390,183 | 631,021 | 947,749 | 1,097,851 | 1,008,950 | 1,210,769 | 3,051,590 |
| Wyoming | 471,259 | 560,876 | 631,932 | 696,151 | 805,911 | 720,828 | 2,421,984 |
| New Mexico | (?) | (?) | 146,421 | 188,703 | 196,924 | 271,442 | 918,606 |
| Utah | 225,000 | 225,000 | 250,000 | 250,000 | 250,000 | 190,286 | 426,000 |
| California | 175,000 | 125,000 | 150,000 | 175,000 | 150,000 | 63,942 | 214,845 |
| Oregon | 30,000 | 30,000 | 30,000 | 50,000 | 50,000 | 44,643 | 125,000 |
| Washington | 175,000 | 175,000 | 225,000 | 300,000 | 300,000 | 339,510 | 950,615 |
| Texas | ..... | ..... | ..... | 100,000 | 100,000 | 133,928 | 300,000 |
| Arkansas | ..... | ..... | ..... | 75,000 | 150,000 | 133,928 | 225,000 |
| Montana | ..... | ..... | ..... | 60,000 | 60,000 | 77,179 | 302,540 |
| Dakota | ..... | ..... | ..... | 50,000 | 31,250 | 23,214 | 91,000 |
| Idaho | ..... | ..... | ..... | 10,000 | 20,000 | 893 | 4,000 |
| Indian Territory | ..... | ..... | ..... | 175,000 | 400,000 | 446,429 | 750,000 |
| Totals | 65,414,844 | 76,865,357 | 86,710,834 | 96,823,198 | 97,518,899 | 95,832,705 | 152,915,268 |

### THE WORLD'S COAL PRODUCTION.

The following table shows the commercial coal produced by the principal governments of the world, compiled by Mr. Ashburner. Long tons of 2,240 pounds are used in giving the statistics of the United States, Great Britain, Australia, India, Nova Scotia, New Zealand, British Columbia, Russia, and "other countries," and metric tons of 2,204 pounds for all continental countries of Europe, except Russia.

*The world's production of coal.*

| Country. | Tons. | Country. | Tons. |
|---|---|---|---|
| Great Britain (1885) | 159,351,361 | New Zealand (1885) | 480,831 |
| United States (1885) | 95,832,705 | India, Bengal (1884) | 1,200,957 |
| Germany and Luxemburg (1884) | 72,113,820 | Borneo (1884) | 5,866 |
| France (1885) | 19,534,341 | Nova Scotia (1885) | 1,352,205 |
| Belgium (1885) | 17,346,771 | British Columbia (1885) | 400,000 |
| Austria and Hungary (1884) | 18,000,000 | Japan (1884) | 900,000 |
| Russia (1884) | 3,950,000 | Australia (1884) | 2,749,109 |
| Sweden (1884) | 250,000 | Other countries (1884) | 10,000,000 |
| Spain (1884) | 952,950 | | |
| Italy (1884) | 220,000 | Total | 404,640,916 |

From this table it is seen that next to Great Britain the United States is the largest coal-producing country in the world; during 1885 its production was nearly one-fourth of the total reported above.

### IMPORTS AND EXPORTS.

The following tables show the movement of coal during recent years, as reported by the custom houses. The values are those declared, and are of course much higher than the "spot" rates which have been used in computing the total annual value of the domestic production.

The tariff from 1824 to 1843 was 6 cents per bushel, or $1.68 per long ton; from 1843 to 1846, $1.75 per ton; 1846, 30 per cent. ad valorem; 1847 to 1861, 24 per cent. ad valorem; 1862 to 1864, $1 per ton; 1865, $1.10; 1866 to 1872, $1.25 per ton; since August, 1872, 75 cents per ton. During the period from June, 1854, to March, 1866, the reciprocity treaty was in force, and coal from the British possessions in North America was admitted into the United States duty free.

The imports are from Australia and British Columbia to San Francisco; from Great Britain to the Atlantic and Pacific coasts, and from Nova Scotia to Atlantic coast ports. The exports are mainly from the lake and Atlantic shipping ports to the Canadian provinces and to the West Indies.

*Coal imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Anthracite. | | Bituminous and shale. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| | *Long tons.* | | *Long tons.* | |
| 1867 | ..... | ..... | 509,802 | $1,412,597 |
| 1868 | ..... | ..... | 394,021 | 1,250,513 |
| 1869 | ..... | ..... | 437,228 | 1,222,119 |
| 1870 | ..... | ..... | 415,729 | 1,103,965 |
| 1871 | 973 | $4,177 | 430,508 | 1,121,914 |
| 1872 | 390 | 1,322 | 485,063 | 1,279,686 |
| 1873 | 2,221 | 10,764 | 460,028 | 1,548,208 |
| 1874 | 471 | 3,224 | 492,063 | 1,937,274 |
| 1875 | 138 | 963 | 436,714 | 1,791,601 |
| 1876 | 1,428 | 8,560 | 400,632 | 1,592,846 |
| 1877 | 630 | 2,220 | 495,816 | 1,782,941 |
| 1878 | 158 | 518 | 572,846 | 1,929,660 |
| 1879 | 488 | 721 | 486,501 | 1,716,209 |
| 1880 | 8 | 40 | 471,818 | 1,588,312 |
| 1881 | 1,207 | 2,628 | 652,963 | 1,988,199 |
| 1882 | 36 | 148 | 795,722 | 2,141,373 |
| 1883 | 507 | 1,172 | 645,924 | 2,013,555 |
| 1884 | 1,448 | 4,404 | 748,995 | 2,494,228 |
| 1885 | 4,976 | 15,848 | 768,477 | 2,548,432 |

*Coal of domestic production exported from the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Anthracite. | | Bituminous and shale. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| | *Long tons.* | | *Long tons.* | |
| 1867 | 192,912 | $1,333,457 | 92,189 | $512,742 |
| 1868 | 192,291 | 1,082,745 | 86,367 | 433,475 |
| 1869 | 283,782 | 1,553,115 | ..... | ..... |
| 1870 | 121,098 | 803,135 | 106,820 | 503,223 |
| 1871 | 134,571 | 805,169 | 133,380 | 564,067 |
| 1872 | 259,567 | 1,375,342 | 141,311 | 586,264 |
| 1873 | 342,180 | 1,827,822 | 242,453 | 1,086,253 |
| 1874 | 401,912 | 2,236,084 | 361,490 | 1,587,666 |
| 1875 | 316,157 | 1,791,626 | 203,189 | 828,943 |
| 1876 | 337,934 | 1,869,434 | 230,144 | 850,711 |
| 1877 | 418,791 | 1,891,351 | 321,665 | 1,024,711 |
| 1878 | 319,477 | 1,006,843 | 340,661 | 1,352,624 |
| 1879 | 386,916 | 1,427,886 | 276,000 | 891,512 |
| 1880 | 392,626 | 1,362,901 | 222,634 | 695,179 |
| 1881 | 462,208 | 2,091,928 | 191,038 | 739,532 |
| 1882 | 553,742 | 2,589,887 | 314,320 | 1,102,898 |
| 1883 | 557,813 | 2,648,033 | 463,051 | 1,593,214 |
| 1884 | 649,040 | 3,053,550 | 646,265 | 1,977,959 |
| 1885 | 588,461 | 2,586,421 | 683,481 | 1,989,541 |

## THE COAL FIELDS OF THE UNITED STATES.

### ALABAMA.

Alabama during 1885 produced 2,225,000 tons of coal, an increase during the year of 225,000 tons, or a little over 11 per cent., while the increase during 1884 was over 40 per cent. This, however, is not to be taken as detrimental to the coal development, since the production of the Alabama fields is approaching more nearly every year to the demand of the market which will take the coal.

The development of the coal fields of this State has been phenomenal. In 1872 only 10,000 tons of coal were mined. The opening up of the Pratt seam in 1879, by the Pratt Coal and Coke Company, for steam, coke, and gas purposes, and the mining of the Helena seam for grate and domestic purposes, gave the trade a great impetus.

The Pratt mines alone are reported now to have an average daily output of 2,000 tons, which was the entire coal tonnage of the Louisville and Nashville railroad six years ago. It is thought by many that the opening up of the Warrior river and the deepening of Mobile harbor will lead to the further development of the Alabama coal trade.

The appended analyses will serve to show the character of some of the more important coal mines:

*Analyses of Alabama coal.*

| | Pratt. | Williams. | Jaggers. | Lost Creek. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Volatile matter | 31.48 | 26.18 | 29.00 | 33.79 |
| Fixed carbon | 61.60 | 66.02 | 56.53 | 57.00 |
| Water | 1.50 | 1.52 | 3.09 | 2.26 |
| Ash | 5.42 | 6.28 | 11.38 | 6.95 |
| Totals | 100.00 | 100.00 | 100.00 | 100.00 |
| Sulphur | .92 | .60 | .57 | .73 |

*Production of coal in Alabama since* 1873.

| Years. | Long tons. | Years. | Long tons. |
|---|---|---|---|
| 1873 | 40,000 | 1881 | 375,000 |
| 1874 | 45,000 | 1882 | 800,000 |
| 1875 | 60,000 | 1883 | 1,400,000 |
| 1876 | 100,000 | 1884 | 2,000,000 |
| 1877 | 175,000 | 1885 | 2,225,000 |
| 1878 | 200,000 | | |
| 1879 | 200,000 | Total for 13 years | 7,960,000 |
| 1880 | 340,000 | | |

## ALASKA.

Coal has been found at several places in Alaska, but most of it is unfit for use for steam coal. At Kellesnoo, Admiralty island, there is a seam of coal which is thus described by the *Alaskan:* "The seam runs at an angle of about 45 degrees, and where the work was suspended in the tunnel there was in all, between the walls, five feet apart, about two feet of coal; the balance of the bed consists of bituminous shale, which will burn to a certain extent." The following analysis of the coal was made by Prof. C. F. Chandler:

*Analysis of coal from Alaska.*

| | Per cent. |
|---|---|
| Water, at 100° C | 3.74 |
| Volatile combustible matter | 37.02 |
| Fixed carbon | 45.15 |
| Ash | 14.09 |
| Total | 100.00 |
| Coke | 59.24 |

There was 0.72 per cent. of sulphur distributed between the last three constituents. The coke is powdery and not coherent. The ash is brown and white. Specific gravity of the coal, 1.45.

The surface croppings of seams, from an inch to a foot wide, are visible almost everywhere in the vicinity of the tunnel. From some horizontal seams several tons of good coal were taken. In one place, after going through the upper seam of coal a foot thick, and then through a few inches of sandstone, another seam of clear coal, a foot in thickness, was cut through and another layer of stone encountered which could not be penetrated owing to the inadequacy of the tools at hand. Another seam, some distance from the tunnel, showed ten inches in thickness on the face, which, at the depth of six feet, had increased to two feet in width.

## ARIZONA.

The extensive coal beds on the San Carlos Indian reservation cannot be utilized under present circumstances, though the settlers are anxious to open and develop them. Coal is known to exist in many places in the Territory, but thus far no effort at systematic development has been made.

## ARKANSAS.

No detailed facts have been obtained as to the amount of coal produced in Arkansas during 1885. The total production is variously estimated at from 150,000 to 175,000 tons. It is believed that the lower estimate is more nearly correct. The output of Sebastian county alone was estimated at 50,000 tons during 1885. The Little Rock and Fort Smith railroad company carried 45,583 tons.

The following are analyses of two prominent coals, the Ouita (No. 1) and Spadra (No. 2) respectively:

*Analyses of coal from Arkansas.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water | 1.77 | 3.80 |
| Volatile combustible matter | 12.66 | 1.076 |
| Fixed carbon | 80.46 | 84.10 |
| Ash | 5.11 | 1.40 |
| Sulphur | 0.78 | (a) |

a Not determined.

These two coals, under the trade classification of the Pennsylvania anthracites, would be called anthracite coals.

## CALIFORNIA.

There are quite a number of places in California where coal has been found in small quantities, and generally of an inferior character, but it is only at the Mount Diablo mines that any extended developments have been carried on. Moreover, the extensive mines of Oregon, Washington, and British Columbia can supply the market with a cheaper and better quality of coal, so that even the Mount Diablo mines are not worked to the same extent as formerly. Australian, English, and Scotch coals are brought in great quantities to San Francisco, by vessels seeking cargoes of wheat at that port, at a price of freight which admits of the coal being sold at a low price.

San Francisco received 899,301 tons of coal in 1883, of which the Mount Diablo mines produced 76,162 tons. Of the total, the Pacific coast produced 392,244 tons. Some of the coast collieries have increased their product materially, and the following statistics show the receipts of coal at San Francisco for the past three years:

*Receipts of Pacific coast coal at San Francisco.*

| Mines. | Location. | 1883. | 1884. | 1885. |
|---|---|---|---|---|
| | | *Short tons.* | *Short tons.* | *Short tons.* |
| Mount Diablo | Mount Diablo, California | 76,162 | 77,485 | 8,020 |
| Seattle | Newcastle, Washington | 139,600 | 125,000 | 75,112 |
| Renton | do | 20,476 | 32,413 | 21,206 |
| Newport | Coos bay, Oregon | ..... | 5,000 | 18,161 |
| South Prairie | Tacoma, Washington | 15,871 | 32,910 | 28,237 |
| Carbon Hill | Carbon Hill, Washington | 140,135 | 122,060 | 157,241 |
| Green River | Washington | ..... | ..... | 43,149 |
| Cedar River | do | ..... | ..... | 20,446 |

More or less of this coal goes direct by sea to Wilmington, the port of Los Angeles, Los Angeles county, California, and the arrivals at that port are included in the above figures.

The various sources from which California derived her coal supplies during the past three years are as follows:

*Sources of California coal supply.*

| | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* |
| British Columbia (Wellington and Nanaimo) | 128,503 | 291,546 | 224,298 |
| Australia | 174,143 | 190,497 | 206,751 |
| English and Welsh | 131,355 | 108,808 | 170,656 |
| Scotch | 21,942 | 21,143 | 20,228 |
| Eastern States (Cumberland and anthracite) | 43,861 | 38,124 | 29,834 |
| Seattle | 139,600 | 125,000 | 75,112 |
| Carbon Hill | 140,135 | 122,060 | 157,241 |
| Green River, Cedar River, Mount Diablo | 76,162 | 77,485 | 71,615 |
| Renton, Newport, South Prairie | 43,600 | 60,413 | 67,604 |
| Total | 899,301 | 1,035,076 | 1,023,339 |

The arrivals at Wilmington are included in the above figures.

The following table of prices from J. W. Harrison's circular will show the monthly fluctuations of foreign coals for "spot" cargoes at San Francisco. The average price is given for each month.

*Average prices of coal in San Francisco in* 1885.

| | Australian. | English steam. | Scotch splint. | West Hartley. |
|---|---|---|---|---|
| January | $6.87½ | $6.87½ | $7.00 | $8.00 |
| February | 6.75 | 6.00 | 6.50 | 7.50 |
| March | 6.50 | 6.00 | 6.50 | 7.50 |
| April | 6.62 | 6.00 | 6.50 | 7.50 |
| May | 6.75 | 6.50 | 6.75 | 8.00 |
| June | 6.62 | 6.50 | 6.75 | 7.75 |
| July | 6.50 | 6.37½ | 6.75 | 7.50 |
| August | 6.25 | 6.00 | 6.50 | 7.50 |
| September | 6.00 | 5.75 | 6.50 | 7.50 |
| October | 5.75 | 5.75 | 6.50 | 7.50 |
| November | 5.75 | 5.62 | 6.62½ | 7.50 |
| December | 5.87½ | 5.50 | 6.62½ | 7.50 |

The San Francisco *Journal of Commerce* gives the following table, showing the imports of foreign coal at San Francisco for twenty-one years:

*Imports of foreign coal into San Francisco for twenty-one years.*

| Years. | British Columbia. | | Great Britain. | | Australia. | | Chili. | | Other countries. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. | Tons. | Value. | Tons. | Value. | Tons. | Value. | Tons. | Value. |
| 1865 | 21,937 | $112,962 | 10,849 | $45,142 | 27,682 | $78,499 | 647 | $1,300 | 1,897 | $10,422 | 63,012 | $248,325 |
| 1866 | 9,066 | 46,887 | 8,220 | 34,091 | 51,551 | 144,659 | 2,200 | 9,312 | 1,048 | 5,222 | 72,085 | 240,171 |
| 1867 | 14,653 | 166,793 | 4,564 | 22,391 | 25,165 | 81,773 | 11,136 | 44,440 | 5,591 | 24,197 | 61,109 | 239,594 |
| 1868 | 22,790 | 123,214 | 28,859 | 94,260 | 31,701 | 89,056 | 8,243 | 34,473 | 742 | 3,348 | 92,305 | 344,351 |
| 1869 | 16,779 | 97,784 | 13,446 | 38,983 | 70,319 | 159,796 | ..... | ..... | 433 | 1,607 | 100,977 | 298,170 |
| 1870 | 13,979 | 84,457 | 28,673 | 79,142 | 84,251 | 182,753 | 7,350 | 34,244 | 2,612 | 21,155 | 136,865 | 401,751 |
| 1871 | 16,004 | 92,093 | 55,478 | 152,013 | 38,751 | 84,125 | 4,179 | 21,972 | 345 | 998 | 114,757 | 351,201 |
| 1872 | 23,574 | 133,772 | 28,059 | 131,234 | 110,111 | 255,465 | 2,644 | 10,823 | 1,826 | 12,234 | 166,214 | 543,528 |
| 1873 | 32,327 | 178,504 | 57,156 | 281,715 | 91,100 | 310,401 | 400 | 2,255 | 1,519 | 10,429 | 182,502 | 783,304 |
| 1874 | 62,672 | 324,362 | 46,932 | 199,447 | 107,010 | 403,860 | ..... | ..... | 1,252 | 7,950 | 217,866 | 935,619 |
| 1875 | 62,110 | 326,588 | 65,932 | 228,188 | 139,164 | 522,792 | ..... | ..... | 183 | 1,138 | 267,389 | 1,078,706 |
| 1876 | 101,572 | 522,555 | 116,836 | 317,927 | 129,097 | 502,102 | 3,203 | 9,799 | 696 | 3,840 | 351,404 | 1,356,223 |
| 1877 | 98,842 | 456,004 | (a)76,750 | 193,214 | 92,768 | 345,943 | 7,259 | (b)26,731 | ..... | ..... | (c)275,619 | 1,021,892 |
| 1878 | 143,241 | 607,427 | 46,722 | 120,935 | 137,684 | 517,186 | ..... | ..... | 9 | 31 | 327,656 | 1,245,579 |
| 1879 | 165,102 | 643,380 | 31,911 | 74,899 | 77,522 | 318,613 | ..... | ..... | ..... | ..... | 274,535 | 1,036,892 |
| 1880 | 178,334 | 638,990 | 61,779 | 103,019 | 51,137 | 195,620 | ..... | ..... | ..... | ..... | 291,250 | 937,629 |
| 1881 | 153,541 | 488,641 | 267,940 | 593,298 | 125,780 | 351,373 | ..... | ..... | ..... | ..... | 547,261 | 1,433,312 |
| 1882 | 144,816 | 496,692 | 163,643 | 403,881 | 165,353 | 487,905 | ..... | ..... | ..... | ..... | 473,812 | 1,388,478 |
| 1883 | 117,822 | 423,831 | 155,102 | 363,676 | 150,318 | 447,407 | ..... | ..... | 6,895 | 8,655 | 430,137 | 1,243,569 |
| 1884 | 254,202 | 1,039,997 | 138,295 | 322,238 | 153,192 | 457,967 | ..... | ..... | 790 | 2,611 | 546,479 | 1,822,813 |
| 1885 | 217,848 | 854,799 | 182 998 | 476,058 | 167,567 | 413,164 | ..... | ..... | ..... | ..... | 568,413 | 1,744,021 |

*a* Exclusive of some cargoes arriving and not clearing, and some not entered. *b* Exclusive of some not entered. *c* Exclusive of several cargoes not entered.

The prices of coal at San Francisco have been low during the past year. Several new collieries came into the field, but still foreign competition continued, and was greater than during the previous year.

The coal mines at Pinacate, San Diego county, are reported as having been lately sold to parties who are to open them. A 7-foot bed has been discovered, but little has been done.

Coal has also been found lately in the Santa Ana cañon. It is described as a 4-foot vein, and is on government land. It is said to have been known 20 years ago, and worked by Mexicans at that time, but afterwards abandoned. At this writing no developments have been made sufficient to determine the value of the bed.

There is a small production of the Amador and Placer county lignites, which is locally consumed, the average product being about the same as in 1884.

A coal seam, 4 miles from Elsinore, in San Diego county, has a tunnel 125 feet long, in the face of which is a bed from 4 to 7 feet thick. The quality of the coal is not good.

At Livermore, in Alameda county, a 4-foot vein of coal has been found, and is utilized to some extent locally, for domestic purposes.

A coal bed 18 miles west of Huron, Fresno county, is 4½ to 5 feet thick, and its product has been found good for domestic use. The coal has been mined and used locally for a long time.

## COLORADO.

During 1885 only one new coal field was opened in Colorado, the Cimarron or Cutler; steps have been taken, however, to open the coking coals on Rock creek in Gunnison county. As a general rule the mining of coal in the State has been profitable, little loss having occurred from strikes, except at the Union Pacific mines in the northern part of the State. This loss has, however, been more than compensated for by the increased production of the Colorado Coal and Iron company. The strikes grew out of those at the Wyoming coal mines in September, and existed only at the Northup, Boulder Valley, and Welch mines. As a result of this strike the Union Coal company, which operated these mines, has now ceased mining coal in Boulder and Weld counties. The increased production of the Marshall mine more than that of any other mine was largely due to this strike, the output in November alone probably exceeding the total output in 1884.

No new mines were opened. The demand for coal did not increase beyond the assured capacity of the mines already in operation. Nothing of general interest here has occurred in the coal-mining districts, except the introduction of coal-cutting machines into the Marshall mines, which will have direct communication with Denver by the Denver, Marshall, and Boulder railway, now nearly completed.

A very thorough and complete study of western Colorado coals is being made by Mr. R. C. Hills, of Denver, and through his kindness some valuable notes and analyses of coals from northwestern Colorado have been obtained. The work on which Mr. Hills is engaged is not yet fully completed, and the next volume of the "Mineral Resources" will contain fuller notes on the subject. All the analyses of coal have been made from samples taken personally by Mr. Hills.

*Analysis of anthracite coal from Union Pacific land west of Irwin, Colorado.*

| | Per cent. |
|---|---|
| Water | 3.8 |
| Volatile matter | 3.9 |
| Fixed carbon | 87.7 |
| Ash | 4.6 |
| Total | 100.0 |

Bed 3 feet thick, dipping north 15° west. Specific gravity at 16° C., 1.526.

*Analyses of anthracite coal from Thompson's bank, Colorado.*

| | East tunnel. | West tunnel. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water | 1.3 | 1.8 |
| Volatile matter | 3.9 | 3.9 |
| Fixed carbon | 90.3 | 87.8 |
| Ash | 4.5 | 6.5 |
| Totals | 100.0 | 100.0 |
| Specific gravity at 16° C | 1.492 | 1.558 |

*Analyses of anthracite coal from Thatcher's mine, Colorado.*

| | East tunnel. | West tunnel. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water | 1.6 | 2.3 |
| Volatile matter | 3.3 | 3.5 |
| Fixed carbon | 90.6 | 87.7 |
| Ash | 4.5 | 6.5 |
| Totals | 100.0 | 100.0 |
| Specific gravity at 16° C | 1.468 | 1.587 |

The samples were taken from Thatcher's openings, about 1 mile east of Thompson's bank; bed in east tunnel 3 feet thick, dipping north 20° west. In the west tunnel the bed is 3½ feet thick, dipping north 15° west.]

From 15 to 20 miles north-northwest of this anthracite field occurs the Ragged Mountain anthracite district. Here openings have been made in two mines, the Black Diamond and Tuscarora.

In the Black Diamond, the bed is 5 feet thick, the coal benches being separated by from 1½ to 2 feet of shale, included in the bed.

*Analyses of anthracite from the Ragged Mountain district, Colorado.*

| | Upper bench. | Lower bench. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water | 1.9 | 2.1 |
| Volatile matter | 5.1 | 6.4 |
| Fixed carbon | 89.6 | 88.0 |
| Ash | 3.4 | 3.5 |
| Total | 100.0 | 100.0 |
| Specific gravity at 16° C | 1.379 | 1.389 |

In Tuscarora the bed of anthracite is about 6 feet thick, with 4 inches of shale in the center, and dips north fifty-four degrees west.

*Analysis of anthracite from Tuscarora, Colorado.*

| | Per cent. |
|---|---|
| Water | 2.0 |
| Volatile matter | 6.5 |
| Fixed carbon | 86.3 |
| Ash | 5.2 |
| Total | 100.0 |
| Specific gravity at 16° C | 1.362 |

No development has been made of the Ragged Mountain anthracite bed.

The coal fields on the Grand river produce a coking coal. The mine known as Wheeler's Old Bank is on the north fork of Thompson creek, and about 40 miles from Aspen. The bed is from 12 to 14 feet thick. The coal cokes well, but is too high in ash to be valuable. The mine has been abandoned.

Wheeler's New Bank is on Edgerton creek, about 4 miles distant from the old mine, and a little nearer Aspen. The bed is 5½ feet thick, and dips south forty degrees west. Analyses show:

*Analyses of coal from Wheeler's banks, Colorado.*

| | New Bank. | Old Bank. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water | 2.5 | 2.0 |
| Volatile matter | 37.9 | 29.4 |
| Fixed carbon | 57.0 | 48.2 |
| Ash | 2.6 | 20.4 |
| Total | 100.0 | 100.0 |

The coal cokes well, and five ovens are now in operation making coke for the smelter at Aspen. To the north of these fields coal beds are opened at numerous points. The following brief description of these

beds, yet undeveloped, will suffice to show the character of the coal which they contain:

*Analyses of coal from Four-Mile creek mine, near Glenwood springs.*

| | 5-foot bed. | 15-foot bed. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water | 11.7 | 11.1 |
| Volatile matter | 31.4 | 33.5 |
| Fixed carbon | 53.5 | 51.2 |
| Ash | 3.4 | 4.2 |
| Totals | 100.0 | 100.0 |

*South Cañon creek, near Glenwood springs, semi-coking coal, 12 feet thick.*

| | Top bench. | Middle bench. | Bottom bench. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Water | 5.4 | 5.1 | 4.7 |
| Volatile matter | 38.2 | 37.9 | 35.9 |
| Fixed carbon | 53.3 | 52.5 | 52 1 |
| Ash | 3.1 | 4.5 | 7.3 |
| Totals | 100.0 | 100.0 | 100.0 |

*Grand river, at the north of Elk creek, 14-foot seam, semi-coking coal.*

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Water | 10.1 | 2.4 | 2.4 |
| Volatile matter | 31.1 | 32.7 | 37.1 |
| Fixed carbon | 51.2 | 48.8 | 58.3 |
| Ash | 7.6 | 16.1 | 2.2 |
| Totals | 100.0 | 100.0 | 100.0 |

The first analysis does not fairly represent the coal, which had been ignited on the outcrop and was still burning partially in the end of the short tunnel from which the sample was taken. The second analysis below the above seam is from a bed which is 5½ feet thick. The coal is bright, lustrous, quite brittle, and semi-coking.

Lower still there is a 5-foot seam of dirty coal. Below this occurs a 4-foot bed of semi-coking coal, the composition of which is shown in the third analysis.

On Highland pass, between Elk and Rifle creeks, there is a 12-foot seam of semi-coking coal. Its composition is—

| | Per cent. |
|---|---|
| Water | 4.7 |
| Volatile matter | 36.8 |
| Fixed carbon | 54.4 |
| Ash | 4.1 |
| Total | 100.0 |

There are four workable coal beds outcropping at Highland pass. The dip of the bed is 50° west. On White river, near Meeker, there are several seams of good coal.

The following are typical analyses:

| | 12-foot seam. | | 6-foot seam. | |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Water | 7.3 | 7.0 | 7.0 | 6.8 |
| Volatile matter | 38.8 | 36.0 | 39.0 | 38.7 |
| Fixed carbon | 50.2 | 50.0 | 48.0 | 48.5 |
| Ash | 3.7 | 7.0 | 6.0 | 6.0 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

The 12-foot seam was formerly worked for the use of the White river Indian agency at Meeker.

Near Bear river, on Sage creek, there is an outcrop of a 10-foot seam, showing a lustrous and brittle coal, dipping 40° west and containing—

| | Per cent. |
|---|---|
| Water | 6.5 |
| Volatile matter | 39.5 |
| Fixed carbon | 50.5 |
| Ash | 3.5 |
| Total | 100.0 |

In the Little Book cliffs, north of Grand Junction, two seams of coal occur, the upper of which is 10 feet thick and the lower 7 feet. They have been opened only to a small extent, and produce a semi-coking coal, analyses of which show—

| | Upper seam. | Lower seam. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water | 8.2 | 5.7 |
| Volatile matter | 34.3 | 36.3 |
| Fixed carbon | 53.5 | 46.5 |
| Ash | 4.0 | 11.5 |
| Total | 100.0 | 100.0 |

The sulphur in none of these coals has yet been tested.

The principal coal mines of Colorado are owned or controlled by the railway companies in the State. The companies operating on the largest scale, and the corporate names under which they transact their mining operations, are the following: Denver and Rio Grande Railway, Colorado Coal and Iron Company; Union Pacific Railway, Union Coal Company; Burlington and Missouri River Railroad, Colorado Fuel Company; Atchison, Topeka and Santa Fé Railroad, Cañon City and Trinidad Coal and Coking Companies; Denver and New Orleans Railroad, New Orleans Coal Mining Company; Denver, Utah and Pacific Railroad, Mitchell

Coal Mining Company. Of these the largest is the Colorado Coal and Iron Company, which has its headquarters at South Pueblo, and controls mines in Fremont, Las Animas, Huerfano, and Gunnison counties. It owns all the important coking-coal beds as far as opened in the State, except that of the Trinidad Coal and Coking Company, and those in Garfield county, now operated on a limited scale.

The production of coal by this company is shown by the following table:

*Production of coal by the Colorado Coal and Iron Company.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1873 | 12,187 | 1880 | 221,378 |
| 1874 | 18,092 | 1881 | 350,944 |
| 1875 | 15,278 | 1882 | 511,239 |
| 1876 | 20,816 | 1883 | 602,396 |
| 1877 | 44,410 | 1884 | 450,808 |
| 1878 | 82,140 | 1885 | 562,660 |
| 1879 | 120,102 | | |

The greater portion of this coal is consumed by the Rio Grande railway; the rest is used by the company's steel works for making coke, or is sold.

*Statement showing the production of the company's mines in* 1885.

| Name and location. | Short tons. |
|---|---|
| Coal Creek Mine, Fremont county | 104,033 |
| Oak Creek, Fremont county | 25,066 |
| El Moro, Las Animas county | 264,206 |
| Walsen Mine, Huerfano county | 89,441 |
| Crested Butte Mine, Gunnison county | 79,914 |
| Total | 562,660 |

The Union Coal company embraces the mines owned by the Union Pacific Railway company. This company owns mines mainly in northern Colorado, and the greater part of its production is consumed by the railway for fuel. The principal mines and their production in 1885 were as follows:

*Production of the Union Coal Company's mines in* 1885.

| Name and location of mine. | Short tons. |
|---|---|
| Boulder Valley, Weld county | 732 |
| Welch, Boulder county | 33,646 |
| Como, Park county | 43,752 |
| Baldwin, Gunnison county | 14,175 |
| Total | 92,305 |

Product of other mines owned by railways in Colorado in 1885:

| | Short tons. |
|---|---|
| Burlington and Missouri railroad (Anthracite Mesa coal), Gunnison county | 26,020 |
| Atchison, Topeka and Santa Fé railway: | |
| Cañon City Coal and Coke company, Fremont county | 169,023 |
| Trinidad Coal and Coke company, Las Animas county | 189,525 |
| Denver, Texas and Gulf railroad, Franceville mine, El Paso county | 39,038 |
| Denver, Utah and Pacific railroad, Mitchell mine, Weld county | 28,413 |
| **The total product of mines operated for the benefit of railways in Colorado in 1885 was** | **1,106,984** |

In the Central division, all the mines show a decrease of production in 1885, except those near Cañon City, where the output was twice as great as in 1884.

The mines of Fremont county have been worked to a larger extent than heretofore, and show an increased production; the output in 1885 having been more than twice as great as in 1884. The coal is a favorite for domestic use throughout the State. The new mines here, the Thornton and Caldwell, are assuming importance as producers.

In the Southern field there has been considerable increase at El Moro, Starkville, and Walsenburg.

In the northwestern section there has also been a fair increase, the product of the Colorado Coal and Iron Company's mine being enlarged to meet the growing demand from Utah and Nevada smelters for the coke made from this coal.

The Jerome Park mine, in Pitkin county, appears as a producer of importance; 4,500 tons of coking coal having been mined here, all of which was made into coke for the use of the Aspen Smelting company at Aspen.

*Coal production of Colorado from* 1864 *to* 1885

| Years. | Localities. | Short tons. | |
|---|---|---|---|
| 1864 | Jefferson and Boulder counties | | 500 |
| 1865 | do | | 1,200 |
| 1866 | do | | 6,400 |
| 1867 | do | | 17,000 |
| 1868 | do | | 10,500 |
| 1869 | do | | 8,000 |
| 1870 | do | | 13,500 |
| 1871 | do | | 15,860 |
| 1872 | do | 14,200 | |
| | Weld county | 54,340 | |
| | | | 68,540 |
| 1873 | Jefferson and Boulder counties | 14,000 | |
| | Weld county | 43,790 | |
| | Las Animas and Fremont counties | 12,187 | |
| | | | 69,977 |
| 1874 | Jefferson and Boulder counties | 15,000 | |
| | Weld county | 44,280 | |
| | Las Animas and Fremont counties | 18,092 | |
| | | | 77,372 |
| 1875 | Jefferson and Boulder counties | 23,700 | |
| | Weld county | 59,860 | |
| | Las Animas and Fremont counties | 15,278 | |
| | | | 98,838 |
| 1876 | Jefferson and Boulder counties | 28,750 | |
| | Weld county | 68,600 | |
| | Las Animas and Fremont counties | 20,316 | |
| | | | 117,666 |
| 1877 | | | 160,000 |
| 1878 | Northern division | 87,825 | |
| | Central division | 73,137 | |
| | Southern division | 39,668 | |
| | | | 200,630 |
| 1879 | Northern division | 182,630 | |
| | Central division | 70,647 | |
| | Southern division | 69,455 | |
| | | | 322,732 |
| 1880 | Northern division | 123,518 | |
| | Central division | 136,020 | |
| | Southern division | 126,403 | |
| | Northwestern division | 1,064 | |
| | Unreported mines | 50,000 | |
| | | | 437,005 |
| 1881 | Northern division | 156,126 | |
| | Central division | 174,882 | |

*Coal production of Colorado from* 1864 *to* 1885—Continued.

| Years. | Localities. | Short tons. | |
|---|---|---|---|
| 1881 | Southern division | 269,045 | |
| | Northwestern division | 6,691 | |
| | Unreported mines | 100,000 | |
| | | | 706,744 |
| 1882 | Northern division | 300,000 | |
| | Central division | 243,694 | |
| | Southern division | 474,285 | |
| | Northwestern division | 43,500 | |
| | | | 1,061,479 |
| 1883 | Northern division: | | |
| | Mines near Erie and Canfield | 80,165 | |
| | Louisville | 97,138 | |
| | Langford | 45,500 | |
| | Golden | 21,100 | |
| | | | 243,903 |
| | Central division: | | |
| | Mines near Sedalia | 1,500 | |
| | Franceville | 54,416 | |
| | Como | 60,140 | |
| | Cañon City | 280,345 | |
| | | | 396,401 |
| | Southern division: | | |
| | Mines near Trinidad and El Moro | 400,929 | |
| | Walsenburg | 87,689 | |
| | Durango and Rico | 12,689 | |
| | | | 501,307 |
| | Northwestern division: | | |
| | Mines near Crested Butte | | 87,982 |
| | Total, 1883 | | 1,229,593 |
| 1884 | Northern division | 253,282 | |
| | Central division | 296,188 | |
| | Southern division | 483,865 | |
| | Northwestern division | 96,689 | |
| | | | 1,130,024 |
| 1885 | Northern division: | | |
| | Mines near Erie and Canfield | 111,089 | |
| | Louisville | 33,646 | |
| | Langford | 75,392 | |
| | Golden | 22,719 | |
| | | | 242,846 |
| | Central division: | | |
| | Mines near Sedalia | 1,500 | |
| | Franceville | 44,083 | |
| | Como | 43,752 | |
| | Cañon City | 327,038 | |
| | | | 416,373 |
| | Southern division: | | |
| | Mines near Trinidad and El Moro | 463,731 | |
| | Walsenburg | 89,441 | |
| | Durango | 15,147 | |
| | La Veta | 125 | |
| | Rico | 3,240 | |
| | | | 571,684 |
| | Northwestern division: | | |
| | Mines near Crested Butte | 79,914 | |
| | Baldwin | 14,175 | |
| | Keubler | 250 | |
| | Wheeler's | 4,500 | |
| | Four Mile | 300 | |
| | Anthracite coal | 26,020 | |
| | | | 125,159 |
| | Total 1885 | | 1,356,062 |

The statement shows a very gratifying increase of 226,238 tons over the product in 1884, or about 16 per cent. The increasing railway and manufacturing developments of the State will call yet more heavily upon the coal mines in future, and it seems not improbable that the now unavailable deposits in northwestern Colorado, particularly in Garfield county, will show a large product within a year.

The number of miners employed in coal mines was about 2,200. Prices paid for coal mining vary from 60 cents to $1.25 per ton. The value of the coal product in 1885 may be averaged at about $2.25 per ton at the mines, a total of $3,051,589 for 1885. There are about fifty producing coal mines now in operation in Colorado.

### DAKOTA.

Western Dakota shows the rocks of the Laramie formation over a vast extent of country, and a large portion of this Territory is probably underlaid by seams of coal of varying thickness and quality, but similar to those of the eastern coal field of Montana. As in all the northwestern Territories, lack of surveys render all estimates of the area underlaid by coal worthless. In 1874 the government land office estimated the coal area at 100,000 square miles, but investigations have shown that this estimate is much too great, and the probability is that only a comparatively small area is underlaid by coal beds. Although some coal deposits are known to occur north of the Black Hills and elsewhere, the development of coal beds has been confined thus far to two localities, Sims and Little Missouri, where the Northern Pacific Coal company has opened mines. The Little Missouri mine is near the western boundary of the Territory, on the line of the Northern Pacific railroad. The coal produced here is a poor lignite. The coal has been superseded entirely for use on locomotives by the greatly superior coals found elsewhere on the Northern Pacific, notably at Bozeman, Montana. Reports of coal discoveries in this Territory continue to be made, and it is reported that there is coal in 4-foot seams, equal to Illinois soft coal, in the country around the headwaters of the Morean river, and between the Morean and Grand rivers. No practical business has been carried on to any extent. A total of 26,000 tons is credited for the year 1885 against about 35,000 tons for the preceding year; the decrease being accounted for by the fact that better coal can be had in Montana, while the supply from Duluth of first-class coal at low prices is considerable.

### GEORGIA.

No reliable statistics have been gathered of the amount of coal mined in the northwestern part of the State. It is currently reported that the annual production for both 1884 and 1885 was 200,000 tons. It is believed that upon a conservative estimate the coal production during 1885 did not exceed 150,000 short tons.

### IDAHO.

There is some coal on Thompson Fork, in eastern Idaho, and at Cokeville, near the Wyoming line. The coal output of the Territory in 1885 did not exceed 1,000 short tons.

## ILLINOIS.

The statistics of coal in Illinois for 1885 have been fully reported by Mr. John S. Lord, secretary of the State Bureau of Labor Statistics, as follows:

*Coal statistics of Illinois.*

| | |
|---|---|
| Number of counties producing coal | 49 |
| Number of mines and openings of all kinds | 780 |
| Number of employés of all kinds | 25,446 |
| Number of short tons of coal mined | 9,791,874 |
| Aggregate value of the same at the mines | $11,456,493 |
| Average value per ton at the mines | $1.17 |
| Average number of days of active operations | 225 |
| Average price per ton paid for mining | $0.725 |
| Number of kegs of powder used | 140,382 |
| Number of men killed | 39 |
| Number of men injured so as to lose time | 176 |
| Number of tons mined for each life lost | 251,073 |
| Number of employés for each life lost | 652 |

These summaries present some noteworthy differences and contrasts with the results obtained in former years. The number of mines and openings of all kinds reported this year is considerably larger than before, which is due in part to the opening of new coal, but probably more to the fact that the territory in the several districts is receiving more careful scrutiny each year, and certain small mines in remote regions are thus being brought to light. There are forty-six more openings reported this year than last, though during the year nine mines have for various reasons been closed and abandoned. This makes the total number of active openings seven hundred and seventy-eight, or an increase of thirty-seven over the aggregate of last year. Of this total of so-called mines, nineteen are "strippings," or places where the coal lies so near the surface that the soil can be profitably removed, uncovering the seam, so that it can be quarried like stone.

An analysis of the mines of this State, based upon the relative amount of their output, shows in general not only the proportion of small to large mines, but also the classes which have increased in numbers. The following tabulation presents a grouping of the mines for the last three years:

| Years. | Mines producing less than 1,000 tons. | Mines producing from 1,000 to 10,000 tons. | Mines producing from 10,000 to 50,000 tons. | Mines producing over 50,000 tons. | Total. |
|---|---|---|---|---|---|
| | *Number.* | *Number.* | *Number.* | *Number.* | *Number.* |
| 1883 | 209 | 233 | 135 | 62 | 639 |
| 1884 | 262 | 273 | 146 | 60 | 741 |
| 1885 | 286 | 290 | 139 | 63 | 778 |

From this it is seen, that the increase in numbers is wholly among the smaller mines, or at least among the mines which have produced during the past year less than 10,000 tons.

*Production and prices in Illinois.*—Notwithstanding the increase in the number of mines given, the total output of the State has been somewhat less than in either of the two years immediately preceding. The total tonnage of 1884 was 10,101,005; in 1885 it was 9,791,874, a difference of 309,131 tons. This falling off in product is traceable to the third and fourth districts, the output of the other districts being substantially the same as last year. In these two districts occurred the longest strike of the greatest number of men reported for the year. The Ellsworth Coal company has twelve collieries, six in Macoupin county, and two recently acquired in Madison county, in the fourth district, and four in the vicinity of Danville, in the third district. In the first group there was a suspension of over three months, and in the last of four months. In Macoupin county the strike extended to some neighboring mines also, and the number of men involved was about 1,375, which, added to 325 in the Danville district, makes a total of 1,700 men who were idle for over three months. We find the total shrinkage of product in the field covered by this strike, as shown by the reports of the two years, to be 317,458 tons. But prior to this strike the amount of coal mined had been greater than in former years, owing to an enlargement of the capacity of some of the lately acquired property of the Ellsworth company, so that the real disparity is not so great as would otherwise have appeared.

The subjoined table shows the record of the State as a producer of coal for the last five years in comparison with the output of 1870 as shown by the United States Census Report of that year:

| Year. | First district. | Second district. | Third district. | Fourth district. | Fifth district. | Total. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| 1870 | | | | | | 2,624,163 |
| 1880 | 1,631,440 | 696,046 | 1,185,189 | 1,022,718 | 1,579,984 | 6,115,377 |
| 1882 | 2,540,532 | 710,526 | 1,350,020 | 2,075,244 | 2,412,321 | 9,088,643 |
| 1883 | 2,495,072 | 831,522 | 1,585,108 | 3,128,368 | 1,990,921 | 10,030,991 |
| 1884 | 2,507,370 | 726,341 | 1,932,881 | 2,804,183 | 2,128,230 | 10,101,005 |
| 1885 | 2,519,397 | 723,077 | 1,811,405 | 2,615,992 | 2,122,003 | 9,791,874 |

*Average value of coal per short ton at the mines in Illinois.*

| Districts. | 1882. | 1883. | 1884. | 1885. | Percentage decline. |
|---|---|---|---|---|---|
| First | $1 75 | $1 59 | $1 49 | $1 41 | 19 |
| Second | 1 87 | 1 97 | 1 79 | 1 71 | 9 |
| Third | 1 43 | 1 45 | 1 31 | 1 25 | 12 |
| Fourth | 1 33 | 1 32 | 1 09 | 98.5 | 26 |
| Fifth | 1 31 | 1 26 | 96.1 | 89.4 | 32 |
| The State | 1 51 | 1 48 | 1 26 | 1 17 | 22 |

This shows a decline since 1882 in the average market value of coal in Illinois from $1.51 to $1.17 per ton, or about 22 per cent.

## INDIANA.

The following is compiled principally from data collected by Mr. Thomas McQuade, mine inspector. There are 96 mines in the State that employ 10 men or more, the total number of all coal mines being estimated as 215.

The 96 mines are distributed in the counties of the State as follows: Clay, 27; Davies, 10; Dubois, 2; Fountain, 7; Greene, 2; Knox, 2; Pike, 4; Sullivan, 7; Vigo, 8; Vermillion, 3; Vanderburgh, 5; and Warrick, 7.

Of these, 58 mines produce bituminous coal, 26 block, 10 semi-block, and 2 bituminous and cannel combined. Out of the 27 mines in Clay county, 23 produce block coal.

*Annual production of coal in Indiana for 13 years.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1873 | 1,000,000 | 1880 | 1,500,000 |
| 1874 | 812,000 | 1881 | 1,771,536 |
| 1875 | 800,000 | 1882 | 1,976,470 |
| 1876 | 950,000 | 1883 | 2,560,000 |
| 1877 | 1,000,000 | 1884 | 2,260,000 |
| 1878 | 1,000,000 | 1885 | 2,375,000 |
| 1879 | 1,196,490 | | |

During 1885 there were less strikes among the miners than during 1884, so that the production for 1885 was 115,000 greater than for 1884, although 185,000 tons less than for 1883.

The amount of capital employed is estimated at $1,850,000. This is $100,000 more than for any former year. This can be accounted for by the number of improvements and new coal openings made during 1885. Of 32 accidents during the year, 7 were fatal. Of all, two-thirds resulted from roof falls.

## INDIAN TERRITORY.

The total production of coal in the Territory for 1885 was about 500,000 tons, which would cover the coal shipped and that sold locally.

The Osage Coal Mining company mined and shipped from McAlister 199,882 tons, and the Atoka company mined and shipped from Savannah and Lehigh 250,000 tons.

## IOWA.

The following table, compiled by Mr. Park C. Wilson, State mine inspector, contains the number of tons produced in each county for 5 years. In several instances the mines have not reported their total output:

| Name of county. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Mahaska | 917,495 | 701,397 | 927,387 | 932,714 | 762,785 |
| Keokuk | 463,010 | 511,849 | 500,040 | 430,940 | 372,816 |
| Lucas | 458,274 | 413,217 | 487,821 | 410,729 | 439,956 |
| Polk | 473,893 | 327,819 | 558,821 | 619,921 | 462,895 |
| Boone | 337,724 | 286,891 | 466,981 | 473,073 | 458,191 |
| Webster | 184,300 | 218,478 | 248,560 | 214,014 | 145,296 |
| Wapello | 131,815 | 207,721 | 237,821 | 240,720 | 187,911 |
| Appanoose | 107,348 | 97,976 | 128,896 | 158,986 | 245,896 |
| Monroe | 98,143 | 90,325 | 93,435 | 98,427 | 101,517 |
| Marion | 93,997 | 90,927 | 90,985 | 97,085 | 100,011 |
| Greene | 81,580 | 62,531 | 88,851 | 96,327 | 89,587 |
| Jasper | 42,435 | 40,189 | 45,883 | 46,321 | 90,425 |
| Dallas | 47,884 | 36,201 | 38,008 | 37,185 | 32,986 |
| Jefferson | 39,124 | 22,121 | 38,887 | 8,172 | 1,116 |
| Warren | 12,987 | 11,081 | 12,828 | 13,727 | 12,825 |
| Scott | 3,804 | 3,711 | 3,714 | 3,821 | 5,937 |
| Hardin | 1,317 | 1,125 | 1,203 | 1,075 | 885 |
| Adams | 3,708 | 1,691 | 3,891 | 3,981 | 3,896 |
| Hamilton | 1,787 | 871 | 1,998 | 1,878 | 918 |
| Wayne | 77 | 51 | 1,892 | 4,947 | 25,812 |
| Van Buren | 98 | 216 | 1,678 | 1,778 | 1,193 |
| Davis | 489 | 301 | 527 | 1,207 | 33,655 |
| Page | 685 | 118 | 748 | 1,009 | 1,819 |
| Taylor | 78 | 84 | 94 | 127 | 617 |
| Henry | 67 | 65 | 65 | 87 | 196 |
| Cass | 36 | 41 | 43 | ..... | ..... |
| Guthrie | ..... | ..... | ..... | 5,187 | 4,596 |
| Total | 3,500,765 | 3,126,997 | 3,981,057 | 3,903,438 | 3,579,737 |

For the year 1885 returns were made from 417 mines, leaving 72 mines not reported.

It will be noticed that the output for 1885 is 317,701 tons less than for 1884. This deficiency is attributed to several causes, one of which was the protracted strike at What Cheer, in Keokuk county, and at Angus, in Boone county; another cause is the increasing competition of the Illinois coal. The operators in the latter State have reduced the cost of mining to 40 cents per ton as against 75 cents to $1 per ton in Iowa.

## KANSAS.

The State mine inspector, Mr. John R. Braidwood, has reported full statistics of coal mining in Kansas for 1885. The coal mines produced 25,931,851 bushels (1,037,274 short tons), and the stripped banks 4,370,576 bushels (174,823 short tons), an aggregate of 30,302,427 bushels (1,212,097 short tons), or 2,802,427 bushels (112,097 short tons) more than were produced in 1884.

The following table exhibits the production of the coal mines in each county of the State, together with the value of the coal at the mines, and the amount of capital invested:

*Coal production of Kansas.*

| Name of county. | Number of bushels mined. | Value of product. | Capital invested. |
|---|---|---|---|
| Crawford | 3,832,717 | $145,873.21 | $332,100 |
| Cherokee | 9,260,681 | 344,116.61 | 481,300 |
| Osage | 8,460,711 | 490,171.22 | 183,000 |
| Shawnee | 95,600 | 9,082.00 | 4,200 |
| Coffey | 11,582 | 1,042.38 | 1,800 |
| Franklin | 344,952 | 23,165.48 | 17,700 |
| Douglas | 20,000 | 1,700.00 | 1,500 |
| Cloud | 102,948 | 7,721.10 | 2,650 |
| Republic | 60,785 | 4,558.88 | 3,650 |
| Ellsworth | 82,708 | 7,089.47 | 3,500 |
| Lincoln | 69,365 | 6,687.17 | 4,100 |
| Russell | 3,500 | 310.00 | 700 |
| Neosho | 191,500 | 14,362.50 | 1,600 |
| Linn | 113,911 | 6,030.55 | 10,000 |
| Leavenworth | 3,014,024 | 120,560.96 | 375,000 |
| Bourbon | 66,867 | 4,179.19 | 8,150 |
| Labette | 200,000 | 14,000.00 | |
| Total | 25,931,851 | 1,200,650.72 | 1,430,950 |

This production would represent about 1,037,314 short tons.

The amount of stripped coal produced in the different counties is shown in the following table:

| Counties. | Total number of bushels of coal mined in each county. | Cost price per bushel for putting coal on board cars. | Total value of the product at the cost price, ready for shipment. |
|---|---|---|---|
| | *Bushels.* | *Cents per bushel.* | *Value.* |
| Labette | 200,000 | 7 | $14,000.00 |
| Crawford | 1,760,816 | 5½ | 96,844.88 |
| Cherokee | 37,574 | 6 | 2,254.44 |
| Linn | 25,000 | 6½ | 1,625.00 |
| Bourbon | 311,000 | 7 | 21,770.00 |
| Coffey | 215,100 | 8½ | 18,283.00 |
| Osage | 803,086 | 7¼ | 58,223.73 |
| Franklin | 18,000 | 7½ | 1,350.00 |
| All other coal mined in the State, in 1885, estimated | 1,000,000 | 7 | 70,000.00 |
| Total | 4,370,576 | | 284,351.05 |

To strip and get out ready for market the above amount of coal, will give employment to 856 head of horses, at 50 cents per head per day, and 856 men, at $1.50 per day each, for 166 days out of the year. The largest amount of stripped coal mined in the year is in the winter season—in the months of October, November, December, January, February, and March. This work is done largely by the surrounding farmers of the neighborhood where the coal is mined. It is a valuable help, and almost a clear gain to them, as they and their horses would evidently be idle pretty much all this time of the year if they did not get this work to do. There are some men who follow stripping as a trade.

For each of the twelve months of 1885 there were 3,597 miners and 578 laborers employed about the mines, an increase over 1884 of 951 miners and 290 laborers.

Since January, 1884, a great many small mines have been abandoned, which makes the number much less to-day than it was then. In the beginning of 1884 there were 273 mines in the State; in January, 1886, there were a little less than 200. Although the number has fallen off

the quality and production have increased. The business is becoming more concentrated, and the mines are worked in a more systematic way. They are handled by more capital. Their capacity is being increased, so that about 200 mines to-day can produce more and better coal than 273 could two years ago.

## KENTUCKY.

The output of the Kentucky mines for 1885 is estimated at 1,700,000 long tons. This includes all coal shipped to outside markets, and that consumed locally in the vicinity of the mines.

For 1884 Mr. C. J. Norwood reported the output from the three distinct fields, as follows:

| | Long tons. |
|---|---|
| Western coal field | 875,593 |
| Southeastern coal field | 384,031 |
| Northeastern coal field | 278,630 |
| Total | 1,538,254 |

The estimate published in the "Mineral Resources" for 1884 gave the total production as 1,550,000 tons. This would cover the tonnage reported by Mr. Norwood and additional local sales. The following table is a detailed report for the last four years, of the production of the mines along the principal transportation routes in the western coal field:

| | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Henderson division of Louisville and Nashville railroad | 269,600 | 364,360 | 340,887 | 357,745 |
| Chesapeake and Ohio and Southwestern railroads | 274,700 | 324,552 | 292,071 | 282,660 |
| Green river | 96,000 | 108,000 | 118,000 | 78,000 |
| Ohio river below Green river | 60,000 | 72,500 | 62,000 | 75,000 |
| Ohio river above Green river | 60,000 | 76,000 | 66,000 | ..... |
| Total | 760,300 | 945,412 | 878,958 | 793,405 |

The decrease in the output on the Ohio and Green rivers has been accounted for by the consumption of Pittsburgh nut and slack coal. These two coals have been thrown on the market by the use of natural gas in the vicinity of that city. Slack coal carried 42 miles sold at 60 cents per ton, and nut coal carried 70 miles, loaded on barges alongside of steamboats, sold at $1.43 per ton.

The yearly production for the past thirteen years has been as follows:

*Production of coal in Kentucky.*

| Years. | Long tons. | Years. | Long tons. |
|---|---|---|---|
| 1873 | 300,000 | 1880 | 1,000,000 |
| 1874 | 360,000 | 1881 | 1,100,000 |
| 1875 | 500,000 | 1882 | 1,300,000 |
| 1876 | 650,000 | 1883 | 1,650,000 |
| 1877 | 850,000 | 1884 | 1,550,000 |
| 1878 | 900,000 | 1885 | 1,700,000 |
| 1879 | 1,000,000 | | |
| | | Total since 1872 | 12,860,000 |

## MARYLAND.

The Cumberland (George's Creek) region constitutes the producing coal field of the State. During 1885 it produced 2,865,974 long tons. The production since 1873, as represented by the shipments over the Baltimore and Ohio, the Chesapeake and Ohio, and the Pennsylvania State Line branch is shown in the following table:

*Coal shipments from Maryland.*

| Years. | Baltimore and Ohio. | Chesapeake and Ohio. | Pennsylvania State Line. | Total. |
|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| 1873 | 1,780,710 | 778,802 | 114,589 | 2,674,101 |
| 1874 | 1,576,160 | 767,064 | 67,671 | 2,410,895 |
| 1875 | 1,302,237 | 879,838 | 160,698 | 2,342,773 |
| 1876 | 1,070,775 | 632,440 | 131,866 | 1,835,081 |
| 1877 | 818,450 | 584,996 | 170,884 | 1,574,330 |
| 1878 | 924,254 | 609,204 | 145,864 | 1,679,322 |
| 1879 | 1,075,198 | 501,247 | 154,264 | 1,730,709 |
| 1880 | 1,319,589 | 603,125 | 213,446 | 2,136,160 |
| 1881 | 1,478,502 | 504,818 | 278,598 | 2,261,918 |
| 1882 | 1,085,249 | 269,782 | 185,435 | 1,540,466 |
| 1883 | 1,434,766 | 680,119 | 419,288 | 2,544,173 |
| 1884 | 2,233,928 | 344,954 | 356,097 | 2,934,979 |
| 1885 | 2,076,485 | 368,744 | 420,745 | 2,865,974 |

The production by the different companies in the region for the last three years has been as follows:

*Coal production in Maryland.*

| Companies. | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* |
| Consolidation Coal company | 456,238 | 689,212 | 710,064 |
| New Central Coal company | 210,850 | 210,140 | 203,814 |
| George's Creek Coal and Iron company | 257,490 | 266,042 | 257,343 |
| Maryland Union Coal company | 137,105 | 117,180 | 98,095 |
| Borden Mining company | 151,665 | 162,057 | 179,537 |
| Maryland Coal company | 235,854 | 295,736 | 365,319 |
| American Coal company | 190,055 | 194,330 | 220,339 |
| Potomac Coal company | 139,723 | 169,463 | 196,280 |
| Hampshire and Baltimore Coal company | 194,534 | 36,416 | ..... |
| Atlantic and George's Creek Coal company | 69,000 | 75,467 | 64,938 |
| Swanton Mining company | 34,905 | 28,620 | 52,862 |
| Blæn Avon Coal company | 84,721 | 100,961 | 69,192 |
| West Virginia Central and Pittsburgh Railroad company | 262,874 | 382,508 | 269,883 |
| Piedmont Coal and Iron company | 4,619 | 1,250 | 32 |
| Union Mining company | 5,024 | 5,310 | 5,641 |
| Big Vein Coal company | 70,430 | 83,170 | 66,326 |
| National Coal | 38,998 | 42,680 | 48,307 |
| Davis mines | ..... | 74,437 | 58,002 |
| Totals | 2,544,085 | 2,934,979 | 2,865,974 |

The following are the average prices for Cumberland coal at Baltimore for the past fourteen years:

*Prices of Cumberland coal.*

| Years. | Prices. | Years. | Prices. |
|---|---|---|---|
| 1872 | $4.52 | 1879 | $2.75 |
| 1873 | 4.83 | 1880 | 3.75 |
| 1874 | 4.70 | 1881 | 3.75 |
| 1875 | 4.35 | 1882 | 3.50 |
| 1876 | 3.87 | 1883 | 2.90 |
| 1877 | 3.15 | 1884 | 2.40 |
| 1878 | 2.86 | 1885 | 2.25 |

The low price for 1885 resulted from competition with the Clearfield, Beech Creek (Pennsylvania) coals, and the New River and Pocahontas (Virginia and West Virginia) coals.

The prevailing miners' wages in the Cumberland region since 1856 have been as follows:

*Wages of Cumberland coal miners, per ton.*

1856—January to May, 1862, 30 cents.
1862—In June advanced to 40 cents, and in September to 45 cents.
1863—January to March, 1864, 50 cents.
1864—In April advanced to 60 cents, and in June to 75 cents.
1864—September to May, 1865, $1.
1865—In June reduced to 75 cents, at which it continued to May, 1866.
1866—May, reduced to 65 cents.
1877—In January reduced to 50 cents; advanced in August to 55 cents.
1878—March, 40 cents, at which it continued until October 15, 1879.
1879—October, 50 cents, at which rate it continued till February, 1880.
1880—February, advanced to 65 cents, at which rate it continued till March 15, 1882. Then strike until August 24.
1882—August 24, 50 cents, until November 15, 1884.
1884—November 15, 40 cents, at which it continues.

The following analyses will show the general character of the coal from this region:

| | George's Creek, analyzed by Prof. A. S. McCreath. | | Hampshire Consolidation. | |
|---|---|---|---|---|
| Water | 1.23 | 1.11 | ..... | 1.01 |
| Volatile matter | 15.47 | 15.30 | 12.30 | 13.92 |
| Fixed carbon | 73.51 | 73.28 | 79.50 | 81.96 |
| Sulphur | .70 | 1.23 | .80 | ..... |
| Ash | 9.09 | 9.08 | 7.40 | 3.11 |
| | 100.00 | 100.00 | 100.00 | 100.00 |

## MICHIGAN.

Mr. Charles D. Lawton, commissioner of mineral statistics for the State, reports that the coal-mining business in Michigan does not make much of a showing. Some of the larger producing mines at Jackson have been worked out and abandoned within the last two years, and there has been but little inducement to push the matter of opening new mines. The price of coal has been too low of late.

It is impossible for the Michigan coal mines, working a thin seam of coal, 2 feet to 3½ feet thick, and contending against a great influx of water, to compete with the Ohio coal mines, which are comparatively dry, and which are worked in beds that are 6 to 8 feet thick.

The Ohio coal is sold in Detroit at $1.80 per ton, a price which it is difficult for a Michigan mine to compete with successfully.

The Michigan coal deposits seem to lie in shallow basins, sometimes so near the surface as to be directly beneath the drift, and thus to be

so situated as to preclude the possibility of working, from the fact that there is no roof (overlying rock) sufficient to support the soil, etc., above. Beds of coal situated in this manner have been opened in several places and have been abandoned for this reason.

The most important of the coal mines at Jackson—the Slope mine, Eureka mine, and the Michigan mine—have been wholly idle during the past two years. It is supposed that the coal has all been taken out; this is especially the case of the Slope.

The following table, showing the product of the Michigan coal mines for the years indicated, is taken from Mr. Charles D. Lawton's report:

*Production of coal in Michigan.*

| | Years previous to 1877. | 1877. | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Williamston mine | ..... | ..... | ..... | ..... | ..... | ..... | 10,454 | 884 | ..... | ..... |
| Jackson mine | ..... | 67,697 | 61,785 | 65,000 | ..... | ..... | ..... | ..... | ..... | ..... |
| Corunna Coal company | ..... | ..... | 22,537 | 16,215 | 12,252 | 7,000 | 8,624 | 9,000 | 8,000 | 10,000 |
| Other mines | ..... | 1,500 | 1,000 | 800 | ..... | ..... | ..... | ..... | ..... | ..... |
| Jackson Coal company | ..... | ..... | ..... | ..... | 66,780 | 61,666 | 60,103 | 40,412 | 13,712 | 15,553 |
| Eureka Coal company | ..... | ..... | ..... | ..... | 30,000 | 37,477 | 25,000 | ..... | ..... | ..... |
| Michigan Coal company | ..... | ..... | ..... | ..... | 20,021 | 23,987 | 25,000 | ..... | ..... | ..... |
| Porter Coal company | ..... | ..... | ..... | ..... | ..... | ..... | 6,158 | 21,000 | 15,000 | 13,000 |
| Star Coal company | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 5,125 |
| Standard Coal company | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1,500 |
| Total | 350,000 | 69,197 | 85,322 | 82,015 | 129,053 | 130,130 | 135,339 | 71,296 | 36,712 | 45,178 |

## MISSOURI.

The lower coal measures in Missouri, according to Prof. G. C. Brodhead, are about 300 feet thick and are composed chiefly of sandstones and shales with a few limestone beds, and include eight or nine beds of coal, of which five are workable, with an aggregate of at least thirteen and a half feet of coal. The middle and lower coal measures are exposed over an area of about 15,000 square miles, the lower measure coming to the surface on the greater part of this area. We know that under 8,000 square miles coal may be practically considered near the surface, and under that area most of the best coals may be reached at a depth less than 200 feet, and therefore the cost of obtaining such coals is trifling, for coals at a depth of 200 feet can be worked almost as cheaply as those nearer the surface. Good coal of workable thickness has been and is mined in the counties of Barton, Vernon, Cedar, Saint Clair, Bates, Henry, Johnson, Pettis, Saline, Cooper, La Fayette, Ray, Carroll, Chariton, Howard, Boone, Callaway, Monroe, Randolph, Macon, Adair, Putnam, Schuyler, and Sullivan. In other counties adjoining these there are coal beds worked with some profit, but they are not so thick, and cannot be mined so economically.

During 1885 there were 2,750,000 long tons of coal mined in this State, of which the Keith and Perry Coal company, of Rich Hill, shipped 172,601 tons and the mines at Carbon Centre produced 198,000 tons. The following table shows the production of the mines of the State since 1873:

*Coal production of Missouri.*

| Years. | Long tons. | Years. | Long tons. |
|---|---|---|---|
| 1873 | 700,000 | 1881 | 1,750,000 |
| 1874 | 714,000 | 1882 | 2,000,000 |
| 1875 | 750,000 | 1883 | 2,250,000 |
| 1876 | 900,000 | 1884 | 2,500 000 |
| 1877 | 900,000 | 1885 | 2,750,000 |
| 1878 | 900,000 | | |
| 1879 | 900,000 | Total | 18,514,000 |
| 1880 | 1,500,000 | | |

## MONTANA.

No new coal field was opened in Montana during 1885. The mines at Lignite, on the Yellowstone, worked in former years, have been permanently closed, the quality of the coal being too inferior for use on the locomotives of the Northern Pacific railway.

The loss in the production of the Lignite mines has been compensated for by an increased production at the Timberline mines, between Bozeman and Livingstone.

As stated on page 52 of the "Mineral Resources" for 1883 and 1884, much of the Territory is underlaid by a very inferior lignite or brown coal, containing an excessive proportion of water and ash, but a small proportion of which is of full value.

To the explored fields named in previous reports, there must now be added the Medicine Lodge field, covering about six square miles. The only coal mining district which has as yet obtained any importance as a producer is the Bozeman, six to eight miles east of the town of Bozeman. The principal mines here are the Timberline, owned by the Northern Pacific Coal company; the Bozeman and Maxey, owned by the Union Pacific, and the Trail Creek, owned by private parties. The Timberline mine has been partially described. Here eight coal seams have been explored which vary in thickness and are badly faulted. The dip ranges from 30° to 60°. The Bonanza seam is alone considered workable. It is a clean, hard bed four feet thick. A recent analysis made by the Northern Pacific Coal company shows:

*Analysis of coal from the Bonanza seam.*

| | Per cent. |
|---|---|
| Water | 2.19 |
| Volatile matter | 21.51 |
| Fixed carbon | 69.67 |
| Ash | 6.63 |
| Total | 100.00 |

This coal makes a good coke, but must be washed before coking, since the raw coal produces a coke containing 20 per cent. of ash. When the coal is washed the coke contains about 12 per cent. of ash.

The Timberline mine was opened in January, 1883. The production has been as follows:

*Production of coal in the Timberline mine.*

| Years. | Short tons. |
|---|---|
| 1883 | 10,489 |
| 1884 | 55,664 |
| 1885 | 83,156 |
| Total | 149,309 |

It is estimated that the Timberline mine will produce 1,000 tons a day as soon as the shaft opening and the 300 and 600 foot levels are completed.

Coal from this mine is used almost exclusively by the Northern Pacific railroad in Montana. General Manager T. F. Oakes speaks of the mine as furnishimg a serviceable coal for locomotives.

The Maxey and Bozeman mines are in the same field as the Timberline and from 3 to 5 miles distant. As at the Timberline mine, the coal is much faulted. In the Maxey mine the dip is nearly 70° and the bed varies in thickness; at one point it is 30 feet. The average thickness of the coal is 7 feet. Analyses of two specimens, taken 30 feet apart, one from hard solid coal and one from a seam of broken coal, showed respectively:

*Analysis.*

| | Hard coal. | Broken coal. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water | 2.95 | 2.80 |
| Volatile matter | 36.65 | 36.85 |
| Fixed carbon | 46.50 | 46.35 |
| Ash | 13.90 | 14.00 |
| Total | 100.00 | 100.00 |

This mine produced 236 tons in 1883 and 394 tons in 1884; it was closed in 1885.

The Bozeman mine is on the same bed as the Maxey, and is distant about one mile. It is similar in many respects to the Maxey mine, but the dip is greater (85°), and the bed thinner, only six feet of clean coal being available.

*Analysis of a sample taken in July, 1885.*

| | Per cent. |
|---|---|
| Water | 2.75 |
| Volatile matter | 33.05 |
| Fixed carbon | 51.32 |
| Ash | 12.88 |
| Total | 100.00 |

The coking quality of this coal is questioned. The mine was formerly worked under a contract with the Northern Pacific railroad.

*Production for three years.*

| Years. | Short tons. |
|---|---|
| 1883 | 8,970 |
| 1884 | 7,612 |
| 1885 | 100 |
| Total | 16,682 |

The Trail Creek mine can only be reached by wagon. The product in 1885 was 609 tons. The beds are said to be large and the coal of good quality.

The Gardiner field is not of great value. Its extent is small, and the coal bed is so much broken that it is improbable that there will ever be any great amount of coal produced. The quality of the coal has already been described. It produced in 1884, 485 tons, and in 1885, 500 tons.

The Rock Creek coal field, on the Crow Indian reservation, was described on page 54 of the "Mineral Resources" for 1883 and 1884. It still remains untouched.

The Sand Coulée coal field occurs in the neighborhood of the Great Falls of the Missouri. The area of the explored field is about 50 square miles. The coal occurs in the strata of the Dakota group. The worked bed varies in thickness from 9 to 18 feet. This coal is favorably situated for working, and can easily be delivered at the town of Great Falls, which is not more than eight miles distant.

*Analyses of the coal.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water | 5.54 | 6.50 |
| Volatile matter | 18.48 | 28.36 |
| Fixed carbon | 64.57 | 59.35 |
| Ash | 11.41 | 5.79 |
| Total | 100.00 | 100.00 |
| Sulphur | .44 | 1.20 |

The coal is only mined to supply a small local demand at Great Falls, Fort Benton, and small consumers in the neighborhood. The production in 1885 was 700 tons.

The Belt Creek coal mines are in the Sand Coulée field, and are similar in almost every respect to those on the Sand Coulée Coal company's property, already described. The production here in 1885 was 1,200 tons.

Near Anaconda occurs a thin seam of coal which has been opened by private parties. It does not exceed 2 feet in thickness, and contains a

large amount of slate. Samples taken in 1885 coked remarkably well, notwithstanding the Northern Pacific Coal company's report that samples of the coal did not coke.

The Medicine Lodge field is at the foot of Medicine Lodge peak, along a stream of the same name, which empties into the Beaverhead river in Beaverhead county. The nearest railway station is Red Rock, on the Utah and Northern railway, 18 miles distant. Three seams of coal are reported to exist, although but one of them has been opened and that below water level. This shows about 5½ feet of lignite. It is owned by the Union Pacific railway.

*Analyses taken in* 1885.

| | Hard coal. | Broken coal. |
|---|---|---|
| Water | 10.00 | 10.35 |
| Volatile matter | 30.20 | 26.00 |
| Fixed carbon | 50.34 | 45.09 |
| Ash | 9.46 | 18.56 |
| Totals | 100.00 | 100.00 |

About 50 tons were taken out in 1885, for the purpose of testing its quality in bulk.

Mines known as the Horr coal mines have been opened at Cinnibar. The coal is reported to be of a good quality.

The other coal fields of Montana, so far as known, have been already described in the second volume of the "Mineral Resources." The total cost of the coal consumed on the Northern Pacific railroad for 1885 was $691,146.07. About one-half of the coal came from Dakota, Montana, and Washington Territory, collectively.

*Coal production of Montana.*

| | Short tons. | | Short tons. |
|---|---|---|---|
| 1883. | | 1885. | |
| Timberline | 10,489 | Timberline | 83,156 |
| Bozeman | 8,970 | Bozeman | 100 |
| Maxey | 236 | Maxey | none. |
| | | Trail Creek | 609 |
| Total | 19,695 | Sand Coulée | 700 |
| | | Belt Creek | 1,200 |
| 1884. | | Anaconda | 75 |
| | | Medicine Lodge | 50 |
| Timberline | 55,664 | Gardiner | 500 |
| Bozeman | 7,612 | Deer Lodge | 50 |
| Maxey | 394 | | |
| Gardiner | 485 | Total | 86,440 |
| Lignite | 16,221 | | |
| Total | 80,376 | | |

The value of the Territory's output in 1885 at $3.50 per ton is $302,540. The number of men employed in coal mining is about 500.

## NEVADA.

A bed of coal was opened in September in the Pittsburgh district near Lewis, located in the Reese river section, by L. W. Getchell and others. It is said to be an old location reopened.

According to the late Prof. W. F. Stewart some of the earliest prospectors after silver and gold ledges reported that they found quite a large deposit of an inferior quality of coal in El Dorado cañon, a few miles east of Dayton, and a large amount of money was expended in the attempt to develop it, but in its deepest explorations no real coal suitable for commercial or domestic use was found. Several tons were hauled to this city and put into practical use, but both in cooking ranges and under steam boilers it was found deficient in heating properties; it cost too much for wood to make it burn. Similar coal beds with like result were opened beyond Como, in Whitman district. The "Whitman coal mines" are laid down on some of the earliest maps. But both quantity and quality were lacking.

In 1864 and 1865 extensive deposits of coal or lignite were opened and explored near Crystal peak, some miles above Reno, where the Truckee river passes out of the mountains. Some beds were several feet thick, but led to nothing better than bituminous shale. It would burn, but gave out too little heat.

Mr. F. F. Chisolm reports that about twenty miles from Battle mountain, Nevada, and near Lewis, new openings were made in 1885 on a coal outcrop which had been prospected previously to some extent. The bed, at the only place found, has been very much faulted and broken, and contains really little but bone. The coal is called anthracite.

*Analysis of a carefully selected sample taken in* 1885.

| | Per cent. |
|---|---|
| Water | 1.45 |
| Volatile matter | 7.55 |
| Fixed carbon | 63.54 |
| Ash | 27.46 |
| Total | 100.00 |
| Sulphur | 4.81 |

The coal seam is probably of little value.

## NEW MEXICO.

The progress of coal mining in New Mexico in 1885 was characterized by nothing of general interest. The principal producers are the mines at Raton, through the Raton Coal and Coking company, and those near San Antonio through the San Pedro Coke company. These mines have been described already, on pages 57 and 58 of "Mineral Resources of the United States, 1883 and 1884." The output here shows an increase

over that in former years, the mines having been worked steadily with no strikes to cause stoppages. The output of the Raton mines in 1885 was 135,833 short tons. The greater proportion of this coal is used by the Atchison, Topeka, and Santa Fé Railroad as fuel. The small amount sold for commercial purposes goes to New Mexico and to Raton, Las Vegas, and other towns on the line of the railway. The coal does not coke. The mines at San Pedro produce an excellent coke which is used generally by the New Mexico and Arizona smelters. The production of coal here in 1885 was 56,656 tons. The Cerrillos field, which produces both anthracite and bituminous coals, has been stagnant in 1885. The mines are some distance from the line of the Santa Fé railway, and being narrow and not easy to work, the coal cannot be put on the market profitably. About 1,000 tons were produced for local use in 1885.

The Monero mines, in Rio Arriba county, supply a portion of the fuel used on the Durango branch of the Denver and Rio Grande railway. The mine is capable of greater production, but the demand is limited. Production here in 1885 was 14,953 tons. In Bernalillo county the increased demand of the Atlantic and Pacific railway has caused a large increase in the production of the two principal mining companies operating here. Some small quantity of the coal is sold at Albuquerque and other points on the line of the road in New Mexico and Arizona. The three largest companies operating here are the Gallup Coal company, which produced, in 1885, 52,269 tons of coal; Bell & Co., who mined in 1885 43,300 tons, and W. A. Maxwell, who mined 2,186 tons, making a total for the locality of 97,755 tons.

The production of the Territory in 1885 was:

| | Short tons. |
|---|---|
| Raton mines | 135, 833 |
| Gallup mines | 97, 755 |
| San Pedro mines | 56, 656 |
| Monero mines | 14, 958 |
| Los Cerrillos | 1, 000 |
| Total | 306, 202 |

The production of the Territory since 1881 has been:

| Years. | Raton. | Gallup. | Monero. | Cerrillos. | San Pedro. | Total. |
|---|---|---|---|---|---|---|
| 1882 | 91, 798 | 33, 373 | 12, 000 | 3, 600 | 16, 321 | 157, 092 |
| 1883 | 112, 089 | 42, 000 | 17, 240 | 3, 060 | 37, 018 | 241, 347 |
| 1884 | 102, 513 | 62, 802 | 11, 203 | 3, 000 | 41, 039 | 220, 557 |
| 1885 | 135, 833 | 97, 755 | 14, 958 | 1, 000 | 56, 656 | 306, 202 |
| Total | 442, 233 | 235, 930 | 55, 401 | 10, 600 | 151, 034 | 895, 198 |

The value of the Territory's product in 1885, at $3 per ton, was $918,606. The total number of men employed is about 700.

## NORTH CAROLINA.

The coal deposits of North Carolina have been examined by Dr. H. Martyn Chance under the direction of the North Carolina State Board of Agriculture, with the view of determining their commercial value.

There are two isolated Triassic areas in North Carolina, in which coal beds have been opened, one situated on the Deep river and the other on the Dan river.

The Deep River coals occur in a series of dark carbonaceous slates, shales, and fire clays, with bands of phosphatic black-band iron ore. These shales form the middle member of the Triassic (Mesozoic), the upper and lower members consisting of red sandstones and shales, with some coarse conglomerates. They dip from 10° to 35° in a southeasterly direction, the average dip being from 20° to 30°. They present only one outcrop, the dip throughout being monoclinal. Coal has been found for a distance of 25 to 30 miles along the outcrop, the most northeasterly locality being near where the Deep and Haw rivers converge to form the Cape Fear; this locality is but a short distance from Farmville. There are five beds of coal lying close together. From the top of the uppermost to the floor of the lowest the distance is not more than 40 or 50 feet. Only two of these beds are of workable thickness, viz., the upper bed, containing 3 feet of good coal, and the lowermost, which is about 22 to 24 inches thick. The upper bed shows the following section:

| | Feet. |
|---|---|
| Slate roof | |
| Coal, good | 3 to 3.2 |
| Blackband and slate | 1.6 to 3 |
| Coal, poor, slaty | 1 to 2 |
| Fireclay, floor | |

The analyses of the upper bench made by the State chemist gave:

| | 1. | 2. | 3.(*a*) | 4.(*b*) | 5.(*c*) | 6.(*d*) |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Moisture at 115° C | 1.79 | 1.95 | 1.71 | 1.36 | 2.15 | 1.32 |
| Volatile combustible matter | 29.56 | 30.54 | 28.66 | 28.71 | 28.88 | 26.87 |
| Fixed carbon | 58.30 | 58.47 | 60.59 | 51.24 | 52.56 | 50.04 |
| Ash | 7.46 | 6.85 | 5.35 | 14.51 | 12.69 | 14.69 |
| Sulphur | 2.89 | 2.19 | 3.69 | 4.18 | 3.72 | 7.08 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

*a* Picked lump coal obtained at depth of 18 feet.
*b* Average of several tons obtained at depth of 28 feet.
*c* Average of several tons obtained at depth of 18 feet.
*d* Picked lump coal mined at depth of 28 feet.

These results show uniform composition, for No. 1 was made from picked lumps, while No. 2 was an average of lump and slack, from a heap containing two or three tons. The lower bed (analyses 3 to 6) was opened at two places by shafts 18 and 28 feet deep, respectively, and from the latter about one hundred tons were mined and shipped to Raleigh for use under the steam boilers at the State exposition. It is undoubtedly a strong steam coal, but is somewhat high in sulphur.

These analyses furnish some food for thought. How can the analysis showing 3.69 of sulphur and only 5.35 of ash be accounted for? The fault is not in the analysis of this sample, at least, since there is reason for special confidence in it. The high ash percentages in Nos.

4 and 5 may be regarded with suspicion, as the coal in burning does not indicate the presence of nearly so large a percentage, and the sulphur percentage in No. 6 is undoubtedly accidental. Averaging the three analyses, Nos. 3, 4, and 5, we may safely assume the sulphur at about 3.86 per cent. The close agreement of the volatile matter in Nos. 3, 4, and 5, is also remarkable in the presence of such marked variations in ash. The physical character of this coal is similar to that of a true coal-measure coal. It has a well developed columnar structure, is hard, bright, and black, with very little pyrites; it burns with a strong flame, and cokes slowly, not commencing to coke until highly heated. The upper bed is much more friable, readily breaking down into fine slack, and cokes quickly and thoroughly. It is evident that only a small portion of the sulphur is in combination with iron as pyrites. The amount of pyrites is so small that it is difficult to detect its presence.

The expense of working the coal in seams two feet thick is estimated at $1.50, and in seams three feet thick at $1.20 per ton. In the mines of Tennessee and West Virginia, with which the North Carolina coal comes in competition, mining is carried on at the rate of 65 cents per ton. Combining these figures with the cost of transportation, it is shown that there would remain sufficient margin in favor of the Deep River coal to command the market in eastern North Carolina. This is favorable to the development of the Deep River deposits; still the fact that these mines have not been worked for many years is significant.

The Richmond coal field, which is of the same age and of the same general character as the Deep River deposit, has been a failure when the mining operations of the whole field are considered. It is evident, therefore, that there must be some sufficient reason why mining in these fields, which are in close proximity to good markets, has not succeeded. Dr. Chance enumerates some of the more obvious difficulties that present themselves in the Deep River area: There are variations in the thickness and quality of the seams, faults, trap-dykes, presence of explosive gas, water, spontaneous combustion, and absence of coal from certain areas. Nearly all of these obstacles are probably much more difficult to surmount in these mines than in the great coal fields to the westward, with which the North Carolina coal comes in competition.

## OHIO.

The coal statistics for 1885 have been very fully compiled and reported by Mr. Thomas B. Bancroft, chief inspector of mines.

Notwithstanding the prevalence of local strikes and stoppages, and the influx of Pittsburgh coal into markets hitherto supplied by Ohio, the output for 1885 has exceeded that of 1884 by 166,117 tons. With this exception the production this year is less than for any year since 1880. The average time made by the mines of Ohio this year was 201 working days, or two days more than in 1884. The product for this

year, as divided between the three inspecting districts, with the number of mines in each district employing more than ten men, is as follows:

*Production of coal, &c., in* 1885.

| | Long tons. | Number of mines. | Number of employés. |
|---|---|---|---|
| First district | 2,758,346 | 114 | 6,741 |
| Second district | 3,206,788 | 142 | 6,466 |
| Third district | 1,851,045 | 88 | 6,497 |
| | 7,816,179 | 344 | 19,704 |

Below will be found the tonnage of the State from 1872 to 1885.

*Production of coal in Ohio.*

| Years. | Long tons. | Years. | Long tons. |
|---|---|---|---|
| 1872 | 5,315,294 | 1879 | 6,000,000 |
| 1873 | 4,550,028 | 1880 | 7,000,000 |
| 1874 | 3,267,585 | 1881 | 8,225,000 |
| 1875 | 4,864,259 | 1882 | 9,450,000 |
| 1876 | 3,500,000 | 1883 | 8,229,429 |
| 1877 | 5,250,000 | 1884 | 7,640,062 |
| 1878 | 5,500,000 | 1885 | 7,816,179 |

In the following table of the coal produced by counties, for the years 1884 and 1885, the estimates are for the calendar years, and are calculated at 2,000 pounds to the ton:

*Coal production in Ohio by counties in* 1884 *and* 1885.

| Counties. | Production 1884. | Production 1885. | | |
|---|---|---|---|---|
| | | Lump. | Nut. | Total. |
| | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| Perry | 1,379,100 | 1,055,500 | 204,092 | 1,259,592 |
| Athens | 627,944 | 677,487 | 145,652 | 823,139 |
| Jackson | 831,720 | 641,419 | 150,189 | 791,608 |
| Belmont | 643,129 | 650,640 | 93,806 | 744,446 |
| Hocking | 372,694 | 574,086 | 82,355 | 656,441 |
| Columbiana | 469,708 | 398,703 | 64,030 | 462,733 |
| Stark | 513,225 | 341,859 | 49,559 | 391,418 |
| Guernsey | 375,427 | 236,366 | 60,901 | 297,267 |
| Tuscarawas | 317,141 | 225,530 | 60,015 | 285,545 |
| Mahoning | 241,599 | 257,561 | 18,383 | 275,944 |
| Jefferson | 316,777 | 245,492 | 25,837 | 271,329 |
| Trumbull | 257,683 | 234,654 | 29,863 | 264,517 |
| Meigs | 248,436 | 199,584 | 35,172 | 234,756 |
| Medina | 77,160 | 136,121 | 16,600 | 152,721 |
| Carroll | 102,531 | 121,125 | 29,570 | 150,695 |
| Lawrence | 176,412 | 111,453 | 34,463 | 145,916 |
| Summit | 253,148 | 129,069 | 16,065 | 145,134 |
| Coshocton | 56,562 | 78,351 | 21,258 | 99,609 |
| Muskingum | 84,398 | 75,511 | 11,335 | 86,846 |
| Wayne | 120,571 | 74,062 | 7,445 | 81,507 |
| Vinton | 69,740 | 67,604 | 9,523 | 77,127 |
| Portage | 65,647 | 67,683 | 9,388 | 77,071 |
| Gallia | 20,372 | 13,477 | 2,906 | 16,383 |
| Holmes | 12,052 | 9,716 | 1,743 | 11,459 |
| Morgan | 7,636 | 5,536 | ..... | 5,536 |
| Washington | 5,600 | 4,000 | 1,000 | 5,000 |
| Scioto | 3,650 | 2,440 | ..... | 2,440 |
| Total | 7,640,062 | 6,635,029 | 1,181,150 | 7,816,179 |

The number of coal mines in the State and the employés by counties is given in the following table:

*Number of coal mines and employés in Ohio, by counties.*

| Counties. | Commercial mines. | Country banks. | Miners. | Outside men. |
|---|---|---|---|---|
| Athens | 27 | 8 | 1,760 | 162 |
| Belmont | 27 | 14 | 980 | 152 |
| Columbiana | 16 | 22 | 769 | 74 |
| Coshocton | 5 | 11 | 194 | 18 |
| Carroll | 11 | ..... | 318 | 36 |
| Guernsey | 12 | 5 | 704 | 83 |
| Gallia | 2 | ..... | 41 | 4 |
| Holmes | 1 | 11 | 49 | 8 |
| Hocking | 16 | ..... | 1,059 | 137 |
| Jackson | 46 | 3 | 1,758 | 179 |
| Jefferson | 13 | 7 | 407 | 92 |
| Lawrence | 5 | 21 | 364 | 32 |
| Medina | 4 | 2 | 539 | 46 |
| Muskingum | 10 | 46 | 330 | 63 |
| Meigs | 11 | 5 | 862 | 87 |
| Mahoning | 16 | 7 | 992 | 102 |
| Perry | 45 | 6 | 2,228 | 236 |
| Portage | 4 | ..... | 251 | 23 |
| Summit | 6 | 3 | 272 | 31 |
| Stark | 26 | 16 | 1,500 | 164 |
| Trumbull | 14 | 3 | 1,402 | 105 |
| Tuscarawas | 18 | 13 | 489 | 79 |
| Vinton | 6 | 8 | 232 | 36 |
| Wayne | 2 | 3 | 208 | 19 |
| Washington | 1 | ..... | 26 | 2 |
| Total | 344 | 214 | 17,734 | 1,970 |

## OREGON.

The coal mines of Oregon are not now producing as much as formerly. The most important mines are those on Coos bay on the western coast, 40 miles north of Cape Blanc. Coal beds have been found on Coal creek, Cowlitz county, and 3 miles back of tidewater, on the creek. It is a lignite coal, has been tested and found good for blacksmithing purposes, and, it is believed, will make good gas. There are four beds, lying about 4 feet apart, with clay between them. One bed is 3½ feet thick, another 4 feet, and two others (each) 4½ feet thick. The beds are not being prospected. The total production for the year probably did not exceed 50,000 tons.

## PENNSYLVANIA ANTHRACITE REGION. (a)

The anthracite region during 1885 produced 34,228,548 long tons.

The region has been grouped into five principal divisions, as follows:

(1) Southern or Pottsville field, extending from the Lehigh river, at Mauch Chunk, southwest to within a few miles of the Susquehanna river, directly north of Harrisburg, and embraced by Carbon, Schuylkill, and Dauphin counties. The eastern end of this field, known as the Lower Lehigh or Panther Creek basin, between Tamaqua, on the Little

a Contributed by Charles A. Ashburner, geologist in charge of the survey of the anthracite coal fields of Pennsylvania.

Schuylkill river, and Mauch Chunk, on the Lehigh river, has generally been included by the coal trade in the Lehigh field, from the fact that its coals resemble more closely the coals obtained in the Upper Lehigh region than those in the Pottsville field west of Tamaqua, and since the shipments to market have almost entirely been made through the Lehigh valley. Production 1885, 3,455,927 tons.

(2) Western Middle or Mahanoy and Shamokin field, lying between the easternmost headwaters of the Little Schuylkill river and the Susquehanna river and within Schuylkill, Columbia, and Northumberland counties. Production 1885, 8,152,937 tons.

These two coal fields (1 and 2) are frequently designated in a general way as the Schuylkill region, although parts of them are better known to the trade by names defining districts from which coals of special characteristics are mined.

(3) Eastern Middle or Upper Lehigh field, lying between the Lehigh river and Catawissa creek and principally in Luzerne county, with limited areas extending into Carbon, Schuylkill, and Columbia counties. Production 1885, 5,329,607 tons.

(4) Northern or Wyoming and Lackawanna field lies in the two valleys from which it derives its geographical name, and is embraced almost entirely by Luzerne and Lackawanna counties. A small area in the extreme northeastern end of the field extends into Wayne and Susquehanna counties. Production 1885, 17,215,066 tons.

(5) Loyalsock and Mehoopany field lies within the area drained by the headwaters of the Loyalsock and Mehoopany creeks, and is contained in Sullivan and Wyoming counties. This field is from 20 to 25 miles northwest of the western end of the northern field. Its geological structure resembles more closely that of the bituminous field, in which it has until recently been included, although the composition of many of its coals entitles them to rank with a number from the anthracite region. Production 1885, 75,011 tons.

The area of the region is about 1,700 square miles. The natural geological and topographical boundaries of this area are formed by the mountains and ridges made by the Pocono Sandstone No. X; no workable coal beds have been found stratigraphically below the Pottsville Conglomerate No. XII., the Lykens Valley or lowest anthracite beds being found in the latter formation. The greatest length of the region, from the northeastern end of the northern field to the southwestern end of the southern field, is about 115 miles, while the greatest width of the belt, containing the first four fields, is about 30 miles between Mauch Chunk and Shickshinny, near the western end of the northern field.

The region is divided into seven inspection districts, as follows:

First. That portion of the Wyoming coal field included in the counties of Lackawanna, Wayne, and Susquehanna. Production 1885, 7,258,753 tons.

Second. The county of Sullivan and that portion of the Wyoming coal field situated in Luzerne county east of and including Plains and Kingston townships. Production 1885, 3,848,549 tons.

Third. The remaining portion of the Wyoming coal field west of Plains and Kingston townships, including the city of Wilkesbarre and the boroughs of Kingston and Edwardsville. Production 1885, 6,182,775 tons.

Fourth. That part of Luzerne county lying south of the Wyoming coal field, together with Carbon county. Production 1885, 5,583,616 tons.

Fifth. That part of the Schuylkill coal field in Schuylkill county lying north of the Broad mountain and east of a meridian line through the center of the borough of Girardville. Production 1885, 4,769,080 tons.

Sixth. That part of the Schuylkill coal field in Schuylkill county lying north of the Broad mountain and west of a meridian line through the center of the borough of Girardville, together with Columbia, Northumberland, and Dauphin counties. Production 1885, 4,204,622 tons.

Seventh. All that part of the Schuylkill coal field in Schuylkill county lying south of the Mahanoy valley and the county of Lebanon. Production 1885, 2,381,153 tons.

The shipment of coal from the entire region since the commencement of mining in 1820 has been carefully reported by Mr. P. W. Sheafer and subsequently by Mr. John H. Jones. From these reports the following table has been compiled:

*Annual shipments of anthracite coal in Pennsylvania since* 1820, *with the number of tons and percentage shipped from each region.*

| Years. | Schuylkill region. | | Lehigh region. | | Wyoming region. | | Total. |
|---|---|---|---|---|---|---|---|
| | *Long tons.* | *Per cent.* | *Long tons.* | *Per cent.* | *Long tons.* | *Per cent.* | *Long tons.* |
| 1820 | | | 365 | | | | 365 |
| 1821 | | | 1,073 | | | | 1,073 |
| 1822 | 1,480 | 39.79 | 2,240 | 60.21 | | | 3,720 |
| 1823 | 1,128 | 16.23 | 5,823 | 83.77 | | | 6,951 |
| 1824 | 1,567 | 14.10 | 9,541 | 85.90 | | | 11,108 |
| 1825 | 6,500 | 18.60 | 28,393 | 81.40 | | | 34,893 |
| 1826 | 16,767 | 34.90 | 31,280 | 65.10 | | | 48,047 |
| 1827 | 31,360 | 49.44 | 32,074 | 50.56 | | | 63,434 |
| 1828 | 47,284 | 61.00 | 30,232 | 39.00 | | | 77,516 |
| 1829 | 79,973 | 71.35 | 25,110 | 22.40 | 7,000 | 6.25 | 112,083 |
| 1830 | 89,984 | 51.50 | 41,750 | 23.90 | 43,000 | 24.60 | 174,734 |
| 1831 | 81,854 | 46.29 | 40,966 | 23.17 | 54,000 | 30.54 | 176,820 |
| 1832 | 209,271 | 57.61 | 70,000 | 19.27 | 84,000 | 23.12 | 363,271 |
| 1833 | 252,971 | 51.87 | 123,001 | 25.22 | 111,777 | 22.91 | 487,749 |
| 1834 | 226,692 | 60.19 | 106,244 | 28.21 | 43,700 | 11.60 | 376,636 |
| 1835 | 339,508 | 60.54 | 131,250 | 23.41 | 90,000 | 16.05 | 560,758 |
| 1836 | 432,045 | 63.16 | 148,211 | 21.66 | 103,861 | 15.18 | 684,117 |
| 1837 | 530,152 | 60.98 | 223,902 | 25.75 | 115,387 | 13.27 | 869,441 |
| 1838 | 446,875 | 60.49 | 213,615 | 28.92 | 78,207 | 10.59 | 738,697 |
| 1839 | 475,077 | 58.05 | 221,025 | 27.01 | 122,300 | 14.94 | 818,402 |
| 1840 | 490,596 | 56.75 | 225,313 | 26.07 | 148,470 | 17.18 | 864,379 |
| 1841 | 624,466 | 65.07 | 143,037 | 14.90 | 192,270 | 20.03 | 959,773 |
| 1842 | 583,273 | 52.62 | 272,540 | 24.59 | 252,599 | 22.79 | 1,108,412 |
| 1843 | 710,200 | 56.21 | 267,793 | 21.19 | 285,665 | 22.60 | 1,263,598 |
| 1844 | 887,937 | 54.45 | 377,002 | 23.12 | 365,911 | 22.43 | 1,630,856 |
| 1845 | 1,131,724 | 56.22 | 429,453 | 21.33 | 451,836 | 22.45 | 2,013,010 |
| 1846 | 1,308,500 | 55.82 | 517,116 | 22.07 | 518,389 | 22.11 | 2,344,003 |
| 1847 | 1,665,735 | 57.79 | 633,507 | 21.98 | 583,067 | 20.23 | 2,882,305 |

*Annual shipments of anthracite coal in Pennsylvania since* 1820, *&c.*—Continued.

| Years. | Schuylkill region. | | Lehigh region. | | Wyoming region. | | Total. |
|---|---|---|---|---|---|---|---|
| | *Long tons.* | *Per cent.* | *Long tons.* | *Per cent.* | *Long tons.* | *Per cent.* | *Long tons.* |
| 1848 | 1,733,721 | 56.12 | 670,321 | 21.70 | 685,196 | 22.18 | 3,089,238 |
| 1849 | 1,728,500 | 53.30 | 781,556 | 24.10 | 732,910 | 22.60 | 3,242,966 |
| 1850 | 1,840,620 | 54.80 | 690,456 | 20.56 | 827,823 | 24.64 | 3,358,899 |
| 1851 | 2,328,525 | 52.34 | 964,224 | 21.68 | 1,156,167 | 25.98 | 4,448,916 |
| 1852 | 2,636,835 | 52.81 | 1,072,136 | 21.47 | 1,284,500 | 25.72 | 4,993,471 |
| 1853 | 2,665,110 | 51.30 | 1,054,309 | 20.29 | 1,475,732 | 28.41 | 5,195,151 |
| 1854 | 3,191,670 | 53.14 | 1,207,186 | 20.13 | 1,603,478 | 26.73 | 6,002,334 |
| 1855 | 3,552,943 | 53.77 | 1,284,113 | 19.43 | 1,771,511 | 26.80 | 6,608,567 |
| 1856 | 3,603,029 | 52.91 | 1,351,970 | 19.52 | 1,972,581 | 28.47 | 6,927,580 |
| 1857 | 3,373,797 | 50.77 | 1,318,541 | 19.84 | 1,952,603 | 29.39 | 6,644,941 |
| 1858 | 3,273,245 | 47.86 | 1,380,030 | 20.18 | 2,186,094 | 31.96 | 6,839,369 |
| 1859 | 3,448,708 | 44.16 | 1,628,311 | 20.86 | 2,731,236 | 34.98 | 7,808,255 |
| 1860 | 3,749,632 | 44.04 | 1,821,674 | 21.40 | 2,941,817 | 34.56 | 8,513,123 |
| 1861 | 3,160,747 | 39.74 | 1,738,377 | 21.85 | 3,055,140 | 38.41 | 7,954,264 |
| 1862 | 3,372,583 | 42.86 | 1,351,054 | 17.17 | 3,145,770 | 39.97 | 7,869,407 |
| 1863 | 3,911,683 | 40.90 | 1,894,713 | 19.80 | 3,759,610 | 39.30 | 9,566,006 |
| 1864 | 4,161,970 | 40.89 | 2,054,669 | 20.19 | 3,960,836 | 38.92 | 10,177,475 |
| 1865 | 4,356,959 | 45.14 | 2,040,913 | 21.14 | 3,254,519 | 33.72 | 9,652,391 |
| 1866 | 5,787,902 | 45.56 | 2,179,364 | 17.15 | 4,736,616 | 37.29 | 12,703,882 |
| 1867 | 5,161,671 | 39.74 | 2,502,054 | 19.27 | 5,325,000 | 40.99 | 12,988,725 |
| 1868 | 5,330,737 | 38.62 | 2,502,582 | 18.13 | 5,968,146 | 43.25 | 13,801,465 |
| 1869 | 5,775,138 | 41.66 | 1,949,673 | 14.06 | 6,141,369 | 44.28 | 13,866,180 |
| 1870 | 4,968,157 | 30.70 | 3,239,374 | 20.02 | 7,974,660 | 49.28 | 16,182,191 |
| 1871 | 6,552,772 | 41.74 | 2,235,707 | 14.24 | 6,911,242 | 44.02 | 15,699,721 |
| 1872 | 6,694,890 | 34.03 | 3,873,339 | 19.70 | 9,101,549 | 46.27 | 19,669,778 |
| 1873 | 7,212,601 | 33.97 | 3,705,596 | 17.46 | 10,309,755 | 48.57 | 21,227,952 |
| 1874 | 6,866,877 | 34.09 | 3,773,836 | 18.73 | 9,504,408 | 47.18 | 20,145,121 |
| 1875 | 6,281,712 | 31.87 | 2,834,605 | 14.38 | 10,596,155 | 53.75 | 19,712,472 |
| 1876 | 6,221,934 | 33.63 | 3,854,919 | 20.84 | 8,424,158 | 45.53 | 18,501,011 |
| 1877 | 8,195,042 | 39.35 | 4,332,760 | 20.80 | 8,300,377 | 39.85 | 20,828,179 |
| 1878 | 6,282,226 | 35.68 | 3,237,449 | 18.40 | 8,085,587 | 45.92 | 17,605,262 |
| 1879 | 8,960,829 | 34.28 | 4,595,567 | 17.58 | 12,586,293 | 48.14 | 26,142,689 |
| 1880 | 7,554,742 | 32.23 | 4,463,221 | 19.05 | 11,419,279 | 48.72 | 23,437,242 |
| 1881 | 9,253,958 | 32.46 | 5,294,676 | 18.58 | 13,951,383 | 48.96 | 28,500,017 |
| 1882 | 9,459,288 | 32.48 | 5,689,437 | 19.54 | 13,971,371 | 47.98 | 29,120,096 |
| 1883 | 10,074,726 | 31.69 | 6,113,809 | 19.23 | 15,604,492 | 49.08 | 31,793,027 |
| 1884 | 9,478,314 | 30.85 | 5,562,226 | 18.11 | (*a*)15,677,753 | 51.04 | 30,718,293 |
| 1885 | 9,488,426 | 30.01 | 5,898,634 | 18.65 | (*a*)16,236,470 | 51.34 | 31,623,530 |
| | 212,365,138 | 37.80 | 106,495,237 | 18.95 | 242,974,965 | 43.25 | 561,835,340 |

*a* Includes Loyalsock field.

No exact determination has been made of the area of the different anthracite coal basins. The general estimates contained in the following table will serve to give an idea as to their relative size:

*Area and total production of individual coal fields.*

| Field. | Square miles (approximated). | 1884. | | 1885. | |
|---|---|---|---|---|---|
| | | *Long tons.* | *Percentage.* | *Long tons.* | *Percentage.* |
| Northern | 200 | 16,411,277 | 50.28 | 17,215,066 | 50.29 |
| Eastern middle | 40 | 5,098,684 | 15.62 | 5,329,607 | 15.57 |
| Western middle | 90 | 7,896,049 | 24.19 | 8,152,937 | 23.82 |
| Southern | 140 | 3,149,471 | 9.65 | 3,455,927 | 10.10 |
| Loyalsock | Unknown | 86,018 | 0.26 | 75,011 | 0.22 |
| Total | 470+ | 32,641,499 | 100.00 | 34,228,548 | 100.00 |

*Total production and shipment from the inspectors' districts for the years* 1884 *and* 1885, *with the colliery and local consumption.*

| District. | No. | Name of inspector. | 1884. Shipment. | 1884. Colliery and local consumption. | 1884. Total production. |
|---|---|---|---|---|---|
| | | | *Long tons.* | *Long tons.* | *Long tons.* |
| First Schuylkill | 1 | Samuel Gay | 1,678,455 | 100,959 | 1,779,414 |
| Second Schuylkill | 2 | Robert Mauchline | 4,246,847 | 270,792 | 4,517,639 |
| Third Schuylkill | 3 | James Ryan | 4,280,487 | 268,865 | 4,549,352 |
| Middle Carbon and Luzerne | 4 | G. M. Williams | 7,435,816 | 446,149 | 7,881,965 |
| Eastern Carbon and Luzerne | 5 | Patrick Blewitt | 8,046,521 | 482,791 | 8,529,312 |
| Southern Carbon and Luzerne | 6 | James E. Roderick | 4,777,156 | 520,643 | 5,297,799 |
| Total production of hard anthracites | | | 30,465,282 | 2,090,199 | 32,555,481 |
| Loyalsock field (Sullivan county), soft anthracite | | | 84,551 | 1,467 | 86,018 |
| Total production of all anthracites | | | 30,549,833 | 2,091,666 | 32,641,499 |

| Number of district under law of June 30, 1885. | Name of inspector. | 1885. Shipment. | 1885. Colliery and local consumption. | 1885. Total production. |
|---|---|---|---|---|
| | | *Long tons.* | *Long tons.* | *Long tons.* |
| First | Patrick Blewitt | 6,829,977 | 428,776 | 7,258,753 |
| Second | Hugh McDonald | 3,686,695 | 161,854 | 3,848,549 |
| Third | G. M. Williams | 6,036,884 | 145,891 | 6,182,775 |
| Fourth | James E. Roderick | 5,055,407 | 528,209 | 5,583,616 |
| Fifth | William Stein | 4,493,075 | 276,005 | 4,769,080 |
| Sixth | James Ryan | 3,965,959 | 238,663 | 4,204,622 |
| Seventh | Samuel Gay | 2,197,424 | 183,729 | 2,381,153 |
| Total production of all anthracites | | 32,265,421 | 1,963,127 | 34,228,548 |

NOTE.—In 1885 a new inspector's district was added in the anthracite region and some of the old boundaries changed, so that the tables for 1884 and 1885 are not directly comparable. In 1885 the Loyalsock was included in the second district.

*Railroad and colliery division of production of individual coal fields for* 1885.

NORTHERN COAL FIELD, RAILROAD DIVISION.

| Railroad. | Long tons. | Percentage. |
|---|---|---|
| Delaware, Lackawanna and Western, main line | 2,593,180 | 36.51 |
| Delaware, Lackawanna and Western, Lackawanna and Bloomsburg division | 3,688,617 | |
| Delaware and Hudson Canal company | 2,584,907 | 15.02 |
| Delaware and Hudson Canal company and Lackawanna and Bloomsburg division of Delaware, Lackawanna and Western railroad | 795,395 | 4.62 |
| Delaware and Hudson Canal company and Lehigh and Susquehanna | 253,745 | 1.47 |
| Delaware and Hudson Canal company and Lehigh Valley | 52,996 | 0.31 |
| Lehigh and Susquehanna | 2,436,495 | 14.15 |
| Lehigh and Susquehanna and North and West branch | 128,899 | .75 |
| Lehigh Valley | 1,452,254 | 8.43 |
| North and West branch (Pennsylvania) | 1,275,765 | 7.41 |
| Pennsylvania Coal company | 1,304,932 | 7.58 |
| Erie and Wyoming Valley | 517,718 | 3.00 |
| New York, Lake Erie and Western | 84,459 | .49 |
| Jefferson branch | 12,170 | .07 |
| Local sales (shipped by wagon) | 33,534 | .19 |
| Total | 17,215,066 | 100.00 |

*Railroad and colliery division of production of individual coal fields for* 1885—Cont'd.

NORTHERN COAL FIELD, COLLIERY DIVISION.

| Operator. | Long tons. | Percentage. |
|---|---|---|
| Delaware, Lackawanna and Western | 2,168,017 | 12.60 |
| Delaware and Hudson Canal company | 3,048,237 | 17.70 |
| Delaware and Hudson and Delaware, Lackawanna and Western | 192,176 | 1.12 |
| Lehigh and Wilkesbarre Coal company | 1,716,682 | 9.97 |
| Susquehanna Coal company | 1,466,735 | 8.51 |
| Lehigh Valley Coal company | 820,755 | 4.83 |
| Pennsylvania Coal company | 1,711,379 | 9.94 |
| Hillside Coal and Iron company | 371,867 | 2.16 |
| Individual operators | 5,709,218 | 33.17 |
| Total | 17,215,066 | 100.00 |

EASTERN MIDDLE COAL FIELD, RAILROAD DIVISION.

| Railroad. | Long tons. | Percentage. |
|---|---|---|
| Lehigh Valley | 2,991,416 | 56.12 |
| Lehigh and Susquehanna | 1,282,109 | 24.06 |
| Lehigh Valley and Lehigh and Susquehanna | 728,979 | 13.67 |
| Sunbury, Hazleton and Wilkesbarre | 327,103 | 6.15 |
| Total | 5,329,607 | 100.00 |

EASTERN MIDDLE COAL FIELD, COLLIERY DIVISION.

| Operator. | Long tons. | Percentage. |
|---|---|---|
| Lehigh and Wilkesbarre Coal company | 500,391 | 9.39 |
| Individual operators | 4,829,216 | 90.61 |
| Total | 5,329,607 | 100.00 |

WESTERN MIDDLE COAL FIELD, RAILROAD DIVISION.

| Railroad. | Long tons. | Percentage. |
|---|---|---|
| Philadelphia and Reading | 5,525,749 | 67.78 |
| Philadelphia and Reading and Northern Central | 330,272 | 4.05 |
| Lehigh Valley | 1,523,256 | 18.68 |
| Northern Central | 619,271 | 7.60 |
| Lehigh Valley and Northern Central | 24,455 | 0.30 |
| Philadelphia and Reading, Northern Central, and Lehigh Valley | 129,934 | 1.59 |
| Total | 8,152,937 | 100.00 |

WESTERN MIDDLE COAL FIELD, COLLIERY DIVISION.

| Operator. | Long tons. | Percentage. |
|---|---|---|
| Philadelphia and Reading Coal and Iron company | 4,417,421 | 54.18 |
| Lehigh Valley Coal company | 460,814 | 5.65 |
| Mineral Railroad and Mining company | 437,167 | 5.36 |
| Individual operators | 2,837,535 | 34.81 |
| Total | 8,152,937 | 100.00 |

*Railroad and colliery division of production of individual coal fields for* 1885—Cont'd.

SOUTHERN COAL FIELD, RAILROAD DIVISION.

| Railroad. | Long tons. | Percentage. |
|---|---|---|
| Philadelphia and Reading | 1,669,805 | 48.33 |
| Lehigh and Susquehanna | 1,224,468 | 35.44 |
| Northern Central | 561,654 | 16.23 |
| Total | 3,455,927 | 100.00 |

SOUTHERN COAL FIELD, COLLIERY DIVISION.

| Operator. | Long tons. | Percentage. |
|---|---|---|
| Philadelphia and Reading Coal and Iron company | 1,249,503 | 36.15 |
| Lehigh Coal and Navigation company | 1,224,468 | 35.43 |
| Summit Branch Railroad company | 344,480 | 9.97 |
| Lykens Valley Coal company | 217,174 | 6.28 |
| Individual operators | 420,302 | 12.17 |
| Total | 3,455,927 | 100.00 |

WESTERN NORTHERN COAL FIELD, RAILROAD DIVISION.

| Railroad. | Long tons. | Percentage. |
|---|---|---|
| Lehigh Valley | 75,011 | 100 |

WESTERN NORTHERN COAL FIELD, COLLIERY DIVISION.

| Operator. | Long tons. | Percentage. |
|---|---|---|
| State Line and Sullivan Railroad company | 75,011 | 100 |

*Total production of coal fields, by counties.*

| Name of county. | 1884. | | 1885. | |
|---|---|---|---|---|
| | Production. | Percentage. | Production. | Percentage. |
| | *Long tons.* | | *Long tons.* | |
| Susquehanna | 77,058 | 0.24 | 84,459 | 0.24 |
| Lackawanna | 7,093,190 | 21.73 | 7,174,294 | 20.96 |
| Luzerne | 13,382,912 | 41.00 | 14,329,645 | 41.86 |
| Sullivan | 86,018 | 0.26 | 75,011 | 0.22 |
| Carbon | 1,155,916 | 3.54 | 1,210,284 | 3.53 |
| Schuylkill | 7,165,532 | 21.96 | 7,700,065 | 22.49 |
| Columbia | 745,826 | 2.28 | 610,552 | 1.81 |
| Northumberland | 2,331,108 | 7.14 | 2,482,644 | 7.25 |
| Dauphin | 603,939 | 1.85 | 561,654 | 1.64 |
| Total | 32,641,499 | 100.00 | 34,228,548 | 100.00 |

*Railroad division of shipments.*

| Railroad. | 1884. | | 1885. | |
|---|---|---|---|---|
| | Shipments. | Percentage. | Shipments. | Percentage. |
| | *Long tons.* | | *Long tons.* | |
| Philadelphia and Reading } Central of New Jersey } | 11,163,920 | 36.34 | 11,680,780 | 36.94 |
| Lehigh Valley | 5,935,254 | 19.32 | 6,107,445 | 19.31 |
| Delaware, Lackawanna and Western | 5,204,362 | 16 94 | 4,987,834 | 15.77 |
| Delaware and Hudson Canal company | 3,362,680 | 10.95 | 3,301,874 | 10.44 |
| Pennsylvania | 3,169,287 | 10.32 | 3,393,685 | 10.73 |
| Pennsylvania Coal Company | 1,397,946 | 4.55 | 1,500,686 | 4.75 |
| New York, Lake Erie and Western | 484,844 | 1.58 | 651,226 | 2.06 |
| Total | 30,718,293 | 100.00 | 31,623,530 | 100.00 |

*Distribution of shipments.*

| Destination. | 1884. | | 1885. | |
|---|---|---|---|---|
| | Long tons. | Percentage. | Long tons. | Percentage. |
| Pennsylvania, New York, and New Jersey | 20,656,297 | 67.24 | 21,132,179 | 66.82 |
| New England States | 5,112,825 | 16.64 | 5,172,964 | 16.36 |
| Western States | 2,736,099 | 8.90 | 3,029,385 | 9.58 |
| Southern States, including Delaware, Maryland, and District of Columbia | 1,336,070 | 4.35 | 1,362,500 | 4,31 |
| Pacific coast | 8,839 | 0.03 | 10,700 | 0.03 |
| Dominion of Canada | 837,185 | 2.73 | 878,177 | 2.78 |
| Foreign ports | 30,978 | 0.11 | 37,624 | 0.12 |
| Total | 30,718,293 | 100.00 | 31,623,529 | 100.00 |

The coals of the producing collieries during the year 1884(*a*) have been classified under the general heads in the following table:

*Number of collieries producing each kind of coal, the amount in tons, and percentage of each.*

| Character of coal. | Number of collieries. | Production 1884. | Percentage of total production 1884. |
|---|---|---|---|
| | | *Long tons.* | |
| Free-burning white ash | 213 | 17,109,523 | 52.41 |
| Hard white ash | 105 | 9,206,639 | 28.20 |
| Wyoming red ash | 14 | 1,727,965 | 5.30 |
| Lehigh red ash | 11 | 1,510,494 | 4.63 |
| Shamokin | 29 | 1,409,854 | 4.32 |
| Lykens Valley red ash | 8 | 1,145,008 | 3.50 |
| Schuylkill red ash | 14 | 227,467 | .71 |
| Trevorton | 2 | 116,695 | .36 |
| Lorberry red ash | 4 | 101,836 | .31 |
| Bernice white ash | 1 | 86,018 | .26 |
| Total | 401 | 32,641,499 | 100.00 |

Mr. Joseph S. Harris, in speaking of the characteristics of the coals produced from the properties of the Philadelphia and Reading Coal and

*a* The producing collieries have not as yet been similarly grouped during the year 1885. These tables for 1884 will be applicable, as far as the percentage column is concerned, to the coal production of 1885, since the number of collieries producing the different grades of coal has only imperceptibly varied.—C. A. A.

Iron company, in the western and southern fields, defines the characteristics of many of these different varieties. Although his definitions were not intended to include the coals from the eastern middle and northern fields, yet, in a general way, they may be considered equally applicable to the special coals from these latter fields. His definitions are as follows:

(1) *Hard white ash.*—"It is in great request for blast furnace and locomotive purposes, having, to an unusual degree, the qualities of resisting change of form under high heat and pressure, and, owing to its high percentage of carbon, it is valuable for producing steam; but for domestic use on a small scale, and for open-grate fires, it does not ignite readily enough to be a favorite."

(2) *Free-burning white ash.*—"The distinction between it and the hard-burning white-ash coal is that under such a fire as is ordinarily used for smelting metals or producing steam the impurities melt or clinker, which is not the case with the harder coal. This practical test is not, however, a very exact one. Some of the anthracites can be clinkered with a strong draught and with a thick bed of fire, and would, by a person who used them under such circumstances, be classed as free burning, while another, whose method of burning was more economical, would call them hard. Analysis shows that the free-burning white-ash coals are quite as rich in fixed carbon, and that they have even higher heating power, as tested by the amount of water evaporated, than the harder variety, but their limited range of usefulness, which is due to their clinkering, prevents their price rising as high as the hard white-ash coals."

(3) *Schuylkill red ash.*—"Is easily ignited, easy to keep burning, and where used in open grates makes less floating dust than white-ash coal, because its ash is composed of larger particles, and on account of the oxide of iron which constitutes its coloring matter has greater specific gravity than the ash of the white."

(4) *Shamokin.*—"It follows in hardness and in ease of ignition next after the free-burning white-ash coals, and is used still more especially for domestic purposes, its lower percentage of carbon making it ill-adapted for purposes requiring intense heat."

(5) *Lorberry red ash.*—"It burns with a little flame, and is much in request for domestic uses in the eastern market."

(6) *Lykens Valley red ash.*—"It burns with considerable flame, and is greatly liked in the eastern market for open grates, or other domestic uses, and for steam and heating purposes, wherever quick heat is required."

(7) *Trevorton or North Franklin white ash.*—"The coal is pure, but its heating properties are rather low, and it is of so friable a nature that it does not stand transportation well."

(8) The Wyoming red ash, (9) Lehigh red ash, and (10) Loyalsock white ash are not referred to in Mr. Harris's report. The Wyoming

red ash is similar in its general characteristics to the Schuylkill red ash. The Lehigh red ash is very similar to the hard white ash produced from the same region, with the exception of the color of the ash, due to the presence of iron, the same as in the softer red ash from Schuylkill, while the Bernice white ash, as a fuel, is rated by many coal men as being similar to the Lykens Valley coal, except in the color of the ash. The geological structure and physical characteristics of the Bernice and Lykens Valley beds are, however, quite different.

The following table shows the amount of the different kinds of coal produced in the different fields, the number of producing collieries in each field from which the different varieties of coals come, and the proportion produced, both in tons and per cent. of total production:

| Coal field. | Character of coal. | Number of collieries. | Production, 1884. | Percenage of total production, 1884. |
|---|---|---|---|---|
| | | | *Long tons.* | |
| Northern | Free-burning white ash | 155 | 14,683,312 | 44.98 |
| | Wyoming red ash | 14 | 1,727,965 | 5.30 |
| Total | | 169 | 16,411,277 | 50.28 |
| Eastern Middle | Hard white ash | 44 | 3,588,190 | 10.99 |
| | Lehigh red ash | 11 | 1,510 494 | 4.63 |
| Total | | 55 | 5,098,684 | 15.62 |
| Western Middle | Hard white ash | 46 | 4,572,762 | 14.01 |
| | Free-burning white ash | 20 | 1,796,738 | 5.50 |
| | Shamokin | 29 | 1,409,854 | 4.32 |
| | Trevorton | 2 | 116,695 | .36 |
| Total | | 97 | 7,896,049 | 24.19 |
| Southern | Lykens Valley red ash | 8 | 1,145,008 | 3.50 |
| | Hard white ash | 15 | 1,045,687 | 3.20 |
| | Free-burning white ash | 38 | 629,473 | 1.93 |
| | Schuylkill red ash | 14 | 227,467 | .71 |
| | Lorberry red ash | 4 | 101,836 | .31 |
| Total | | 79 | 3,149,471 | 9.65 |
| Western Northern | Lykens Valley white ash | 1 | 86,018 | 0.26 |
| Grand total | | 401 | 32,641,499 | 100.00 |

It is found in practice that after the coal is passed through the breaker and screened into different sizes for shipment, the purity of the different sizes, as regards fixed carbon and ash, is very different. This is indicated by the following analyses of specimens collected from the Hauto screen-building of the Lehigh Coal and Navigation company:

| Kind of coal. | Water. | Volatile matter. | Fixed carbon. | Sulphur. | Ash. | Total. | Color of ash. |
|---|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | |
| Egg | 1.722 | 3.518 | 88.489 | .609 | 5.662 | 100 | Light cream. |
| Stove | 1.426 | 4.156 | 83.672 | .572 | 10.174 | 100 | Cream. |
| Chestnut | 1.732 | 4.046 | 80.715 | .841 | 12.666 | 100 | Cream. |
| Pea | 1.700 | 3.894 | 79.045 | .697 | 14.664 | 100 | Cream. |
| Buckwheat | 1.690 | 4.058 | 76.918 | .714 | 16.620 | 100 | Cream. |

These coals are separated into different sizes according to the mesh of the screen over which they pass. The sizes noted in the above table passed over and through sieve meshes of the following dimensions:

| | Through. | Over. |
|---|---|---|
| | *Inches.* | *Inches.* |
| Broken or grate | 4 | 2.5 |
| Egg | 2.5 | 1.75 |
| Stove | 1.75 | 1.25 |
| Chestnut | 1.25 | .75 |
| Pea | .75 | .50 |
| Buckwheat | .50 | .25 |

*Price.*—It is difficult to report the price at which anthracite coal has sold for any definite period. It is generally supposed that this can be obtained from the coal trade circulars; but although circular prices are named by the different companies, and mutually agreed upon, yet coal is often sold in the New York market for $1 and even $1.25 below circular prices.

The average prices of the different sizes of coal free on board at New York harbor, for each different month in 1885, are shown in the following table:

*Prices of anthracite coal in Pennsylvania during* 1885.

| | Broken and egg. | Stove. | Nut. | Pea. |
|---|---|---|---|---|
| January | $2.90 | $3.70 | $3.00 | $2.00 |
| February | 3.20 | 4.05 | 3.42 | 2.25 |
| March | 3.20 | 4.00 | 3.50 | 2.30 |
| April | 3.25 | 3.85 | 3.55 | 2.40 |
| May | 3.25 | 3.75 | 3.40 | 2.25 |
| June | 3.23 | 3.75 | 3.25 | 2.25 |
| July | 3.22 | 3.75 | 3.20 | 2.25 |
| August | 3.12 | 3.70 | 3.10 | 2.00 |
| September | 3.05 | 3.70 | 3.00 | 2.00 |
| October | 3.30 | 3.90 | 3.25 | 2.00 |
| November | 3.30 | 3.90 | 3.20 | 2.00 |
| December | 3.10 | 3.75 | 3.10 | 2.00 |
| Averages | 3.18 | 3.82 | 3.24 | 2.14 |

The Delaware, Lackawanna and Western railroad sold a great proportion of the coal which it mined at public auction from 1869 to 1879, and the average of the prices received by this company at that time may be considered a fair indication of the actual market value of the Wyoming and Lackawanna coals, free on board vessels, at New York shipping points. These prices are shown below. The prices in this table subsequent to 1879 and those in the next table are the average prices received approximately for the same classes of coal at private sale. Many of the variations in the monthly prices are due to the greater or less proportion of the dearer or cheaper sizes of coal which were sold during different months. The prices given are the averages of the sales of all sizes (from lump to pea, inclusive), whatever the proportion of each may have been.

*Value in New York of Wyoming and Lackawanna coals.*

| Years. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Average. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1869 | $5.21 | $4.36 | $4.58 | $4.79 | ..... | ..... | ..... | $6.76 | $6.08 | $6.41 | $4.82 | $5.18 | $5.35 |
| 1870 | 4.42 | 4.32 | 4.77 | 4.59 | $4.51 | $4.57 | $4.89 | 4.77 | 4.65 | 4.30 | 3.99 | ... | 4.53 |
| 1871 | .. | .. | .. | ..... | 5.11 | 4.85 | 4.87 | 5.01 | 5.29 | 4 45 | 4.40 | 4.31 | 5.29 |
| 1872 | 3.76 | 3.81 | 3.78 | 3.61 | 3 60 | 3.62 | 3.53 | 3.47 | 3.99 | 4.11 | 4.24 | 4.13 | 3.80 |
| 1873 | 4.49 | 4.46 | 4.57 | 4.65 | 47.6 | 4.90 | 5.11 | 5.17 | 5.17 | 5.18 | 5.16 | | 4.81 |
| 1874 | 4.89 | 4.64 | 4.68 | 4.79 | 4.87 | 5 06 | 5.16 | 5.20 | 5.37 | 5.53 | 5.49 | 5.36 | 5.09 |
| 1875 | 5.43 | 5.45 | .. .. | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1876 | .. | ..... | ..... | ..... | ..... | ..... | ..... | 2.91 | ..... | 3.27 | 3.00 | 3.09 | 3.09 |
| 1877 | 3.07 | 3.13 | 2.93 | 3.03 | 2.53 | 2 37 | ..... | ..... | ..... | 2.57 | 2.35 | 2.69 | 2.70 |
| 1878 | 3.32 | 3.23 | 3.47 | 3 49 | 3.59 | 3.59 | 3.59 | 3.72 | 3.79 | 3.74 | 3.74 | 2.72 | 3.46 |
| 1879 | 2.50 | 2.45 | 2.35 | 2.28 | 2.24 | 2.40 | 2.56 | 2.24 | 2.19 | ..... | ..... | ..... | 2.33 |
| 1880 | 3.02 | 3.10 | 3.49 | 3.56 | 3.67 | 3 69 | 3.74 | 3.74 | 3.80 | 3.80 | 3.83 | 3.84 | 3.61 |
| 1881 | 3.86 | 3.83 | 3.71 | 3.76 | 3.70 | 3.64 | 3.71 | 3.77 | 3.76 | 3.79 | 3.79 | 3.84 | 3.77 |
| 1882 | 3.72 | 3.58 | 3.63 | 3.59 | 3.65 | 3.66 | 3.78 | 3.91 | 3.95 | 4.06 | 3.92 | 3.70 | 3.76 |
| 1883 | 3.88 | 3.70 | 3.89 | 3 79 | 3.64 | 3.67 | 3.70 | 3.78 | 3.83 | 3.75 | 3.74 | 3.66 | 3.75 |
| 1884 | 3.72 | 3.84 | 3.67 | 3 57 | 3.59 | 3.62 | 3.71 | 3.68 | 3.49 | 3.59 | 3.58 | 3.44 | 3.63 |
| 1885 | 3.13 | 3.39 | 3.40 | 3.38 | 3.39 | 3.21 | 3.23 | 3.09 | 3.20 | 3.28 | 3.04 | 2.81 | 3.21 |

Auction sales.

*Value of Wyoming and Lackawanna coal at private sale.*

| Months. | 1877. | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|---|---|---|
| January | $3.66 | $2.57 | $2.66 | $2.91 | $3.99 | $3.72 | $3.68 | $3.47 | $3.14 |
| February | 3.02 | 2.89 | 2.46 | 2.96 | 4.04 | 3.60 | 3.68 | 3.56 | 3.30 |
| March | 3.62 | 3.37 | 2.42 | 3.59 | 3.95 | 3.57 | 3.61 | 3.44 | 3 31 |
| April | 3.05 | 3.28 | 2.29 | 3.52 | 3.86 | 3.62 | 3.63 | 3.39 | 3.28 |
| May | 2.94 | 3.42 | 2.22 | 3.53 | 3.78 | 3.62 | 3.61 | 3.27 | 3.07 |
| June | 2.66 | 3.29 | 2.35 | 3.61 | 3.75 | 3.70 | 3.68 | 3.44 | 3.09 |
| July | 2.65 | 3.44 | 2.39 | 3.66 | 3.80 | 3.64 | 3.78 | 3.42 | 3.11 |
| August | 2.99 | 3.54 | 2.23 | 3.74 | 3.79 | 3.71 | 3.67 | 3.29 | 2.93 |
| September | 3.07 | 3.49 | 2.19 | 3.85 | 3.68 | 3.81 | 3.63 | 3 36 | 2.99 |
| October | 2.95 | 3.64 | 2.06 | 3.84 | 3.78 | 3.98 | 3.71 | 3.29 | 3.24 |
| November | 2.51 | 3.20 | 2.76 | 3.88 | 3.75 | 4.04 | 3.70 | 3.42 | 2.99 |
| December | 2.25 | 2.95 | 2.91 | 3.92 | 3.99 | 3.87 | 3.48 | 3.43 | 2.90 |
| Average | 2.79 | 3.23 | 2.32 | 3.55 | 3.84 | 3.73 | 3.65 | 3.41 | 3.12 |

*Average monthly prices received for the different Lehigh coals for two and one-half years.*

| Months. | 1883. | 1884. | 1885. |
|---|---|---|---|
| January | ..... | $4.07 | $3.58 |
| February | ..... | 4 19 | 3.57 |
| March | ..... | 4 16 | 3.56 |
| April | ..... | 4.96 | 3.60 |
| May | ..... | 4.05 | 3.61 |
| June | ..... | 4.00 | 3.58 |
| July | $4.23 | 4 02 | 3.52 |
| August | 4.20 | 4.01 | 3.43 |
| September | 4.21 | 3.97 | 3.46 |
| October | 4.25 | 3.91 | 3 50 |
| November | 4.16 | 3.87 | 3.55 |
| December | 4.10 | 3.72 | 3.46 |
| Average | 4.10 | 4.00 | 3.54 |

*Average yearly prices for Schuylkill lump coal at Philadelphia, and Lehigh lump coal at Elizabethport, New Jersey, for the past fourteen years.*

SCHUYLKILL LUMP COAL.

| Years. | Price. | Years. | Price. |
|---|---|---|---|
| 1872 | $3.74 | 1879 | $2.70 |
| 1873 | 4 27 | 1880 | 4.53 |
| 1874 | 4.55 | 1881 | 4.50 |
| 1875 | 4.39 | 1882 | 4.75 |
| 1876 | 3.87 | 1883 | 4.50 |
| 1877 | 2.59 | 1884 | 4.50 |
| 1878 | 3.25 | 1885 | 4.00 |

*Average yearly prices for Schuylkill lump coal at Philadelphia, &c.*—Continued.

LEHIGH LUMP COAL.

| Years. | Price. | Years. | Price. |
|---|---|---|---|
| 1872 | $3.82 | 1879 | $3.29 |
| 1873 | 4.71 | 1880 | 4.63 |
| 1874 | 5.05 | 1881 | 5.10 |
| 1875 | 5.00 | 1882 | 5.25 |
| 1876 | 4.71 | 1883 | 5.00 |
| 1877 | 3.60 | 1884 | 5.00 |
| 1878 | 3.50 | 1885 | 4.50 |

## PENNSYLVANIA—BITUMINOUS.

No thoroughly reliable statistics are collected of the Pennsylvania bituminous coal mines. The inspectors report a production of 22,409,337 short tons for the fourteen months beginning November 1, 1884, and ending December 31, 1885. The Bureau of Industrial Statistics reports a total production for 1885 of 20,647,730 tons. From all the miscellaneous facts which can be collected relating to this region, it is believed that the production of all coal for 1885 was at least 26,000,000 tons. The only statistics which pretend to be complete are those of the Bureau of Industrial Statistics; although these returns are incomplete from the failure of some mines to report, yet they give a comparative idea of the bituminous trade, and the table is therefore inserted in this place.

*Condition of the Pennsylvania bituminous coal mines in* 1885.

| Counties. | Number of mines. | Average number of days operated. | Number of persons employed. | Amount paid in wages. | Number of tons of coal mined. |
|---|---|---|---|---|---|
| | | | | | *Short tons.* |
| Allegheny | 86 | 160 | 11,455 | $3,271,819 | 3,588,244 |
| Armstrong | 4 | 212 | 284 | 92,268 | 139,327 |
| Beaver | 7 | 255 | 389 | 168,611 | 184,631 |
| Bedford | 5 | 195 | 232 | 85,646 | 107,694 |
| Blair | 5 | 160 | 836 | 146,045 | 205,075 |
| Bradford | 2 | 250 | 496 | 225,024 | 249,920 |
| Butler | 8 | 150 | 467 | 96,671 | 85,429 |
| Cambria | 64 | 200 | 1,807 | 560,358 | 1,037,000 |
| Cameron | 1 | 100 | 101 | 13,019 | 7,706 |
| Centre | 9 | 200 | 611 | 185,831 | 373,504 |
| Clarion | 9 | 212 | 626 | 204,195 | 299,216 |
| Clearfield | 64 | 200 | 5,154 | 1,761,615 | 3,368,671 |
| Elk | 7 | 220 | 958 | 421,181 | 537,826 |
| Fayette | 51 | 203 | 5,184 | 1,774,750 | 3,192,972 |
| Greene | 3 | 250 | 33 | 4,502 | 8,248 |
| Huntingdon | 8 | 235 | 543 | 236,620 | 247,424 |
| Indiana | 2 | 200 | 134 | 43,436 | 82,750 |
| Jefferson | 6 | 205 | 736 | 258,885 | 479,675 |
| Lawrence | 3 | 195 | 175 | 49,208 | 42,137 |
| McKean | 3 | 200 | 121 | 46,238 | 44,312 |
| Mercer | 15 | 140 | 901 | 296,898 | 378,508 |
| Somerset | 15 | 193 | 400 | 118,073 | 302,715 |
| Tioga | 8 | 200 | 2,553 | 969,309 | 1,067,081 |
| Venango | 1 | 280 | 16 | 6,851 | 7,000 |
| Washington | 33 | 195 | 3,064 | 833,917 | 836,633 |
| Westmoreland | 57 | 190 | 6,730 | 2,369,804 | 3,774,072 |
| Total for 1885 | 476 | 195 | 44,006 | 14,240,774 | 20,647,730 |
| Total for 1884 | 361 | 213 | 38,906 | 14,752,786 | 18,084,941 |
| Increase | 115 | ..... | 5,100 | ..... | 2,562,779 |
| Decrease | ..... | 18 | ..... | 512,012 | ..... |

The number of days represents the days actually worked by the majority of employés. About one-third of the employés averaged about

one hundred and sixty days only. The annual wage fund, if divided share and share alike among all the employés, would give to each about $323 per annum, or about $27 per month. The highest average wages paid miners was $2 per day. The average wages paid miners was $1.70 per day. The highest average wages paid to common laborers was $1.60 per day. The average wages paid to same was $1.40 per day. Boys received about 60 cents per day.

In commenting upon the above returns, the report of the Bureau says that the total production of "run of mine coal" was about 25,000,000 tons, although this is about four and a half million tons more than is shown by their detail returns, yet it is believed to be at least 1,000,000 tons below the total amount of coal produced.

One of the most productive regions in the State is that known as the Clearfield, and the growth of this field can be appreciated from the following table:

*Returns of the amount of coal carried over the Tyrone and Clearfield branch of the Pennsylvania railroad for the last twenty-four years.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1862 | 7,239 | 1874 | 639,630 |
| 1863 | 24,330 | 1875 | 928,297 |
| 1864 | 65,380 | 1876 | 1,281,861 |
| 1865 | 60,629 | 1877 | 1,374,927 |
| 1866 | 107,878 | 1878 | 1,295,201 |
| 1867 | 166,364 | 1879 | 1,631,120 |
| 1868 | 170,335 | 1880 | 1,739,873 |
| 1869 | 259,994 | 1881 | 2,401,987 |
| 1870 | 379,863 | 1882 | 2,838,970 |
| 1871 | 542,896 | 1883 | 2,857,710 |
| 1872 | 431,915 | 1884 | 3,173,363 |
| 1873 | 592,860 | 1885 | 2,901,613 |

The total production of Clearfield county for 1885 is estimated to be 4,446,637 tons. This includes that shipped over the Tyrone and Clearfield branch; 774,055 tons shipped over the Beech Creek, Clearfield and Southwestern railroad; 120,969 tons shipped by John Whitehead over the Keating and Karthouse branch; and about 200,000 tons shipped over the Bell's Gap railroad, besides some coal sold locally. It is reported that of the coal sent over the Tyrone road, 400,000 tons were sent to Baltimore, 800,000 tons to Philadelphia, and 900,000 to Amboy.

The Broad Top semi-bituminous coal is shipped over the Huntingdon and East Broad Top railroads. The shipment over these two roads respectively is given as follows:

*Huntingdon and Broad Top railroad.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1873 | 350,245 | 1880 | 174,736 |
| 1874 | 226,693 | 1881 | 204,819 |
| 1875 | 204,921 | 1882 | 271,216 |
| 1876 | 159,779 | 1883 | 196,534 |
| 1877 | 140,143 | 1884 | 192,706 |
| 1878 | 150,204 | 1885 | 176,075 |
| 1879 | 141,594 | | |

*Coal carried by the East Broad Top railroad to the Pennsylvania railroad at Mount Union.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1875 | 43, 567 | 1881 | 91, 745 |
| 1876 | 66, 104 | 1882 | 99, 095 |
| 1877 | 54, 738 | 1883 | 44, 737 |
| 1878 | 63, 068 | 1884 | 43, 514 |
| 1879 | 67, 929 | 1885 | 51, 878 |
| 1880 | 72, 450 | | |

*Shipments of Cumberland coal over the Pennsylvania and Huntingdon and Broad Top railroads.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1873 | 114, 589 | 1880 | 242, 593 |
| 1874 | 67, 671 | 1881 | 313, 600 |
| 1875 | 175, 154 | 1882 | 208, 031 |
| 1876 | 145, 796 | 1883 | 471, 785 |
| 1877 | 187, 488 | 1884 | 394, 114 |
| 1878 | 163, 598 | 1885 | 460, 289 |
| 1879 | 171, 930 | | |

The Monongahela region ships its coal both by railroad and boat by means of the slack-water navigation of the Monongahela river, the river being navigable for boats carrying 800 tons during all times of the year. The coal consumed in Pittsburgh is supplied mainly by railroad, and a large portion of the coal shipped by river goes to the markets along the Ohio and Mississippi rivers.

*Shipments by the slack-water navigation since* 1860.

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1860 | 1, 517, 909 | 1873 | 2, 094, 312 |
| 1861 | 834, 630 | 1874 | 2, 503, 504 |
| 1862 | 743, 358 | 1875 | 2, 275, 265 |
| 1863 | 1, 134, 150 | 1876 | 2, 495, 800 |
| 1864 | 1, 402, 828 | 1877 | 2, 677, 460 |
| 1865 | 1, 580, 791 | 1878 | 2, 797, 530 |
| 1866 | 1, 704, 212 | 1879 | 2, 623, 232 |
| 1867 | 1, 202, 908 | 1880 | 3, 361, 934 |
| 1868 | 1, 812, 040 | 1881 | 3, 450, 186 |
| 1869 | 2, 100, 504 | 1882 | 4, 057, 384 |
| 1870 | 2, 303, 856 | 1883 | 4, 339, 492 |
| 1871 | 1, 944, 852 | 1884 | 3, 170, 900 |
| 1872 | 2, 291, 220 | 1885 | 3, 298, 200 |

The price of Monongahela coal has been very low in the Louisville and Cincinnati markets, where it has ranged from 5½ to 7½ cents per bushel, wholesale price. The average price for mining was 2½ cents per bushel, and the average value of the coal during the year was probably 5 cents per bushel at the point of delivery.

In Westmoreland county are located the celebrated Penn and Westmoreland gas coals, near Penn and Irving stations, on the line of the Pennsylvania railroad. This coal is much similar to that from the Youghiogheny mines on the Baltimore and Ohio railroad.

*Westmoreland coal carried by the Pennsylvania railroad since* 1874.

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1874 | 952,971 | 1880 | 943,177 |
| 1875 | 796,968 | 1881 | 982,293 |
| 1876 | 906,139 | 1882 | 1,278,121 |
| 1877 | 786,039 | 1883 | 1,399,702 |
| 1878 | 692,586 | 1884 | 1,320,186 |
| 1879 | 816,302 | 1885 | 1,293,813 |

The Snowshoe coal region is located in Centre county. The Lehigh Valley Coal company is the operator in this region, and during 1885 there were 148,500 tons of coal and 25,643 tons of coke shipped from the district over the Pennsylvania railroad.

*Shipments of coal since* 1873.

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1873 | 95,257 | 1880 | 56,020 |
| 1874 | 63,540 | 1881 | 128,263 |
| 1875 | 62,426 | 1882 | 233,708 |
| 1876 | 51,399 | 1883 | 257,230 |
| 1877 | 42,985 | 1884 | 183,271 |
| 1878 | 29,168 | 1885 | 148,500 |
| 1879 | 56,654 | | |

The collieries in Blair and Cambria counties, along the line of the Pennsylvania railroad and its branches, during 1885 produced about 150,000 tons.

In McKean county, in the northwestern part of the State, the production of coal is rapidly diminishing. The beds are much thinner and the coal much poorer than that in the counties to the south and southwest. The Bureau of Statistics reports the production of this county for 1885 as 44,312 tons.

*Production of McKean county for the past ten years.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1875 | 33,501 | 1881 | 110,099 |
| 1876 | 81,830 | 1882 | 73,834 |
| 1877 | 73,222 | 1883 | 84,899 |
| 1878 | 72,098 | 1884 | 78,870 |
| 1879 | 85,745 | 1885 | (*a*) 44,312 |
| 1880 | 100,046 | | |

*a* Reported by Bureau of Statistics.

In Jefferson and Elk counties rapid developments have been made in the coal fields during the past two years. In these two counties is reported some of the best and most available coal lands in western Pennsylvania, notable among which is the Shawmut tract. No detailed statistics are at hand, however, in regard to their production.

From the Myersdale district, in Somerset county, the production in 1885 is reported at about 200,000 tons, nearly 70,000 tons less than the amount produced in 1884.

In the Blossburg region, Tioga county, there were produced in 1885 1,074,581 tons, divided between the different companies as follows:

| | Tons. |
|---|---|
| Blossburg Coal Company | 264,452 |
| Morris Run Coal Mining Company | 400,722 |
| Fall Brook Coal Company | 409,407 |

This region was first developed in 1840. The total amount of coal which has been produced since that date by the principal companies, has been as follows:

| | Tons. |
|---|---|
| Arbon Coal Company, 1840–'43 | 49,633 |
| William H. Mallory, 1844–'57 | 405,113 |
| D. S. Mcgee, 1856–'59 | 78,996 |
| Tioga Transportation Company | 323,174 |
| Salt Company, of Onondaga, 1863–'66 | 267,809 |
| Morris Run Coal Company, 1864–'85 | 6,450,663 |
| Fall Brook Coal Company, 1860–'85 | 6,293,780 |
| Blossburg Coal Company, 1866–'85 | 4,469,635 |
| Total | 18,338,803 |

*Production of the Blossburg district since* 1872.

| Years. | Tons. | Years. | Tons. |
|---|---|---|---|
| 1872 | 849,262 | 1879 | 874,010 |
| 1873 | 991,057 | 1880 | 921,555 |
| 1874 | 796,388 | 1881 | 1,178,581 |
| 1875 | 581,782 | 1882 | 1,165,604 |
| 1876 | 616,984 | 1883 | 1,217,870 |
| 1877 | 602,245 | 1884 | 1,018,342 |
| 1878 | 652,597 | 1885 | 1,074,581 |

In Bradford county the two principal operating companies are the Towanda Coal Company and the Long Valley Coal Company. The latter produced 48,814 tons during 1885.

*Production of the Towanda Coal company since* 1865.

| Years. | Tons. | Years. | Tons. |
|---|---|---|---|
| 1865 | 6,886 | 1876 | 160,343 |
| 1866 | 3,881 | 1877 | 161,344 |
| 1867 | 27,668 | 1878 | 165,025 |
| 1868 | 67,080 | 1879 | 237,608 |
| 1869 | 176,307 | 1880 | 246,064 |
| 1870 | 196,310 | 1881 | 223,172 |
| 1871 | 249,240 | 1882 | 210,917 |
| 1872 | 263,960 | 1883 | 226,806 |
| 1873 | 252,329 | 1884 | 181,786 |
| 1874 | 215,572 | 1885 | 246,397 |
| 1875 | 200,424 | | |

Between 1856 and 1867 the Barclay Coal Company mined 412,640 tons of coal from their property, which was subsequently leased and worked by the Towanda Coal Company.

The Schrader Coal Company's property adjoins that of the Towanda Coal Company. It is now exhausted.

*Production of the Schrader Coal Company from* 1874 *to* 1884 *inclusive.*

| Years. | Tons. | Years. | Tons. |
|---|---|---|---|
| 1874 | 100,219 | 1880 | 216,802 |
| 1875 | 157,686 | 1881 | 210,654 |
| 1876 | 200,795 | 1882 | 156,956 |
| 1877 | 175,755 | 1883 | 107,870 |
| 1878 | 149,285 | 1884 | 75,074 |
| 1879 | 144,946 | | |

The mines of the McIntyre Coal Company at Ralston, in Lycoming county, Pennsylvania, on the line of the Northern Central railway, are now abandoned. The company began operations in the year 1870, 17,802 tons being shipped during that year, and operations ceased in October, 1884.

*Production of the McIntyre Coal Company.*

| Years. | Tons. | Years. | Tons. |
|---|---|---|---|
| 1871 | 166,138 | 1878 | 154,205 |
| 1872 | 171,420 | 1879 | 127,632 |
| 1873 | 212,462 | 1880 | 216,225 |
| 1874 | 138,907 | 1881 | 236,922 |
| 1875 | 164,507 | 1882 | 209,858 |
| 1876 | 208,701 | 1883 | 184,552 |
| 1877 | 183,715 | 1884 | 84,274 |

*Coal and coke originating on the line of the Pennsylvania railroad division and forwarded from the districts named; also tonnage originating on other lines passing over the Pennsylvania railroad division for the year* 1885.

| | Coal. | Coke. | Total. |
|---|---|---|---|
| *Originating on the line of Pennsylvania railroad division.* | | | |
| | *Short tons.* | *Short tons.* | *Short tons.* |
| Snow Shoe, semi-bituminous | 148,500 | 25,643 | 174,143 |
| Karthaus, semi-bituminous | 120,969 | ..... | 120,969 |
| Tyrone and Clearfield, semi-bituminous | 2,873,876 | ..... | 2,873,876 |
| Gallitzin and Mountain, semi-bituminous | 550,244 | 193,091 | 743,335 |
| West Pennsylvania railroad, semi-bituminous | 219,750 | 64,901 | 284,651 |
| Southwest Pennsylvania railroad, semi-bituminous | 102,689 | 1,999,923 | 2,102,612 |
| Westmoreland region, semi-bituminous | 1,293,813 | 252,397 | 1,546,210 |
| Monongahela region, semi-bituminous | 267,502 | 108,706 | 376,208 |
| Pittsburgh region, semi-bituminous | 236,703 | ..... | 236,703 |
| North and West Branch railroad, anthracite | 1,294,334 | ..... | 1,294,334 |
| Sunbury, Hazleton and Wilkesbarre railroad, anthracite | 321,192 | ..... | 321,192 |
| Total | 7,429,572 | 2,644,661 | 10,074,233 |
| *Originating off the line of the Pennsylvania railroad division.* | | | |
| Anthracite | 3,087,831 | ..... | 3,087,831 |
| Semi-bituminous | 1,062,193 | 57,052 | 1,119,845 |
| Total for 1885 | 11,579,596 | 2,702,313 | 14,281,909 |
| Total for 1884 | 10,454,215 | 2,846,126 | 13,300,341 |

The roads covered by this statement are the main line from Philadelphia to Pittsburgh and the branches in Pennsylvania; the Philadelphia and Erie is not included. It will be seen that 64 per cent. of the

coal carried, and 98 per cent. of the coke—71 per cent. of the entire tonnage—originated on the company's lines.

There is such sharp competition in the bituminous coal trade of the Atlantic seaboard and prices are so fluctuating that it is almost impossible to report an average price for the year of any one coal or the coals of any one State. The "Engineering and Mining Journal," referring to bituminous prices for 1885, says:

"Early in the season the announcement was made that the Pennsylvania and Baltimore and Ohio railroads had decided upon forming a pool, in which the former road would have 55 per cent. of the tidewater business and the latter 45 per cent. This arrangement was to go into effect on March 1. Under it shippers would be compelled to charge for their coal as follows: At Baltimore, $2.25 per ton free on board; at Philadelphia, $2.40 free on board; at New York, $3.25 alongside; and at Boston, $3.50 per ton. The railroad tolls were supposed, upon this basis, to leave shippers about 80 cents a ton for their coal at the mines, and the main line of railroads 3 mills per ton per mile. A commissioner to supervise the workings of the pool was appointed.

"The arrangement was said to have the sympathy of the Norfolk and Western, the Chesapeake and Ohio, and the Beech Creek roads, and this was natural, for it gave them a standard which they had only to 'cut' to take a large part of the trade. This was an opportunity they promptly availed themselves of, and the prices of coal throughout the early part of the season, and until all the usual large contracts had been placed, were quite irregular, and were in New York from 20 to 50 cents a ton below the 'pool prices.'

"Nominally the Baltimore and Ohio and Pennsylvania railroad shippers were to be deprived of low rates and otherwise punished if they 'cut' the pool prices; but the practical working of these arrangements is always understood by the favored few insiders, so that Clearfield and Cumberland coals were sold in New York at $3.15, while some other coals, such as Elk Garden, were sold even in February as low as $2.85 per ton alongside in this city, and in Boston this and other coals were offering at $3.15 to $3.40 a ton. By the end of the month this coal was selling alongside here at $2.75 a ton. About this time it was announced that the West Shore railroad had contracted with a Clearfield firm for 100,000 tons at 9 cents a ton less than the Beech Creek bid. About the middle of March it was reported that the Long Island railroad had contracted for from 25,000 to 40,000 tons of Clearfield coal to be delivered in gondolas at Long Island City at about $2.75.

"Before the end of the month the Pacific Mills contract for the Maryland Coal company's Cumberland coal at the pool price was announced and that of the Portland and Rochester railroad with the Consolidation Coal company at $3.45 a ton delivered. About the middle of April it was stated that the New York and New Haven railroad had contracted with Messrs. J. C. Scott & Co., of the Clearfield district, for 30,000 tons, and with the Pocahontas company for 50,000 tons.

"By this time it became evident that the pool was a failure, and it was said that Clearfield coal sold at $2.70 to $2.80 alongside in this city, and the announcement was made that the National line contract for about 40,000 tons was taken at $2.85. The Hamburg line contracted for about 60,000 tons at a low price. The Hoboken Ferry company secured from 12,000 to 15,000 tons of Clearfield coal at $2.90.

"Early in May Pocahontas coal was offered in Troy at $3.15 a ton. During the latter part of this month Clearfield coal was offered at Newark, New York, on the West Shore road, at very low prices. All rail coal sold in North Adams, Mass., at $3.25 per ton. At this time the Inman line contract for about 40,000 tons, and another with a sugar house for 15,000 tons, went to the Clearfield district. Early in June the Pacific Mail Steamship Company contracted for about 20,000 tons of Beech Creek coal at about $2.75 a ton.

"July opened with Beech Creek coal offered here at $2.60 a ton alongside. Outside of the Alexandre line contract for about 25,000 tons secured by a Clearfield firm, there was little of importance until September, when Beech Creek coal sold at $2.50 a ton alongside steamer. This, we believe, was the bottom of prices, and from this time until the end of the year the business was of an unimportant character, although aggregating a large amount. Under the improving condition of general business, scarcity of cars, &c., prices had a slight inclination to stiffen toward the close of the year, with a more marked tendency that way for the better classes of coals.

"Although there were exceptional cases of lower prices, Cumberland coal sold, as a rule, at $3.15 to $3.25 alongside, New York, and at $2.20 to $2.25 at Georgetown and Baltimore. Clearfield and Pocahontas coals brought about 25 cents less, and Beech Creek about 50 cents less.

"The pool was a complete failure, (1) because it did not include the Chesapeake and Ohio, Norfolk and Western, and the Beech Creek roads, which were waiting for any opportunity to increase their business at any cost, and (2) because of the attempt to fix prices.

"The result of the year's business was alike unsatisfactory to those in, as well as those out of the pool, and all are anxious for some arrangement that will bring about a higher range of prices. The companies outside of the pool made less money on a greatly increased business than they did the year before. Vessel freights became very low during last year, $1.25 to $1.05 being accepted from Baltimore to points east of the Cape."

## TENNESSEE.

The mining of coal in Tennessee on any considerable scale, has been confined to the last fifteen or twenty years. Previous to 1860, coal was very little used outside of Nashville and Memphis, except for blacksmith purposes, and much of that then used was brought from Pittsburgh.

The mining law of the State makes no provision for the collection of statistics, and it is impossible to make any exact estimate of the amount of coal produced in the State, on account of the reluctance shown by the coal operators to furnish this information.

Mr. Saward reports that during 1885 the production was 1,440,957 tons. In this he has probably included the coal used for coke, since Mr. J. C. Guild, State mine inspector, reports the production of coal as 1,000,000 tons and of coke 268,425 tons. The following is Mr. Guild's report on the statistics of coal for 1885:

"District I includes those mines near the Nashville, Chattanooga and Saint Louis railway, namely, the Tennessee Coal, Iron and Railroad Company, and the Etna Coal Company. Coal produced, 162,370 tons; Coke, 115,605 tons.

"District II includes those on or near the line of the Cincinnati Southern railroad, namely, the Tabler-Crudup Coal and Coke Company, the Soddy Coal Company, Walden Ridge Mining Company, Dayton Coal and Iron Company, Roane Iron Company, Poplar Creek Coal Company, Mount Carbon Coal Company, Winter's Gap Coal Company, Eureka Coal Company, Oliver Coal Company, and Glen Mary Coal and Coke Company. Coal produced, 486,334; coke, 152,820 tons.

"District III includes the mines situated on the Knoxville and Ohio division of the East Tennessee, Virginia and Georgia railroad, namely, the Standard Coal and Coke Company, Jellico Mountain Coal and Coke Company, Knoxville Iron Company, Coal Creek Consolidated Mining company, Coal Creek Coal Company, New River Coal Company, and Heck and Petree. Coal produced, 351,296 tons.

"Twenty-two hundred miners alone, and about three thousand five hundred persons altogether, are given employment directly by the mining industry of the State of Tennessee. As near as can be estimated, between twelve thousand and fifteen thousand persons are dependent upon this industry.

The distribution of mines by counties is shown in the following table:

*Distribution of coal mines in Tennessee, by counties.*

| District. | Counties. | County seat. | Number of companies. | Number of openings. |
|---|---|---|---|---|
| I | Grundy | Altamont | 1 | 9 |
| | Marion | Jasper | 1 | 1 |
| II | Hamilton | Chattanooga | 3 | 6 |
| | Rhea | Washington | 1 | 3 |
| | Rhone | Kingston | 1 | 1 |
| | Anderson | Clinton | 5 | 5 |
| | Scott | Huntsville | 1 | 1 |
| III | Campbell | Jacksboro' | 2 | 2 |
| | Anderson | Clinton | 5 | 6 |
| | Total | | 20 | 34 |

"The total production of coal in this State during the year 1885, amounted to 1,000,000 tons; coke, 268,425 tons. In District III no coal

is coked, all being used for domestic and manufacturing purposes. Neither is any coke made at the Poplar Creek mines, in District III, which is also all sold for domestic purposes."

The coal and iron interests of this State are intimately associated; the coal mined at many of the mines being altogether used for the manufacture of coke as fuel for blast furnaces. This branch of the industry has shown the most marked improvement. In the year 1870, there were in the State only two companies using coke ovens, the Etna Coal Company, and the Roane Iron Company, at Rockwood, and both of these together had only thirty ovens. In 1883, there were 1,000 coke ovens in the State, showing a wonderful increase in thirteen years. At the present time there are about 1,254 ovens, which number will be considerably increased during the summer. These are distributed as follows:

| | Ovens. |
|---|---|
| Tennessee Coal, Iron and Railroad Company | 534 |
| Etna Coal Company | 65 |
| Tabler-Crudup Coal and Coke Company | 50 |
| Walden Ridge Mining Company | 25 |
| Shoddy Coal Company | 175 |
| Dayton Coal and Iron Company | 200 |
| Roane Iron Company | 180 |
| Glen Mary Coal and Coke Company | 25 |

These ovens produce 268,425 tons of coke per annum.

*Wages paid for mining coal.*– The wages paid the miners for mining coal in Tennessee are generally fair and just, though quite a number of strikes have occurred, which, in the majority of cases, have been settled by arbitration, the miners returning to work.

The price per ton differs greatly at the different mines, being fixed by the thickness of the coal and the ease with which it is mined.

*Prices paid for mining coal in Tennessee.*

| | Cents per ton. | | Cents per ton. |
|---|---|---|---|
| Tennessee Coal, Iron and Railroad company. (*a*) | 39 | Mount Carbon Coal Company | 50 to 75 |
| Etna Coal Company | 70 | Eureka Coal Company | 50 to 75 |
| Tabler-Crudup Coal and Coke Company | 60 | Oliver Coal Company | 50 to 75 |
| Shoddy Coal Company | 55 to 60 | Glen Mary Coal Company | 75 |
| Walden Ridge Mining Company | 55 to 65 | Standard Coal Company | 75 |
| Dayton Coal and Iron Company | 60 to 100 | Coal Creek Consolidated Mining Company | 62½ |
| Roane Iron Company | 37½ | Coal Creek Mining Company | 62½ |
| Poplar Creek Coal Company | 50 to 75 | New River Coal Company | 62½ |
| Knoxville Iron Company (*b*) | | Heck and Petree | 62½ |
| Winter's Gap Coal Company | 75 | | |

*a* For run of mine. *b* All convicts.

Half a million dollars is paid annually in this State to miners for mining coal alone, exclusive of all money paid for outside labor. It is impossible to give any reliable figures as to the amount of money put in circulation by the mining industry, but the amount probably exceeds $1,000,000 annually in this State.

The mines of this State employ 3,500 men altogether, of whom 2,200 are miners for support. The coal miners can make from $1.50 to $5 per day, according to skill and industry. They are, as a class, prosperous and frugal.

The following table, compiled by Mr. Guild, gives analyses of coals from prominent openings and of coke made from certain coals:

*Analyses of Tennessee coals.*

| Name of coal. | Fixed carbon. | Volatile matter. | Ash. | Sulphur. | Water. | Phosphorus. | |
|---|---|---|---|---|---|---|---|
| Coal Creek | 57.520 | 38.82 | 3.090 | 0.200 | 1.040 | ..... | |
| Do | 57.690 | 37.80 | 2.550 | ..... | ..... | ..... | |
| Poplar Creek | 60.670 | 36.53 | 1.750 | 0.780 | 1.750 | ..... | Potter & Riggs. |
| Do | 59.470 | 40.00 | 0.530 | 1.260 | ..... | ..... | Joliet I. and S. Co. |
| Careyville (new mine) | 56.850 | 38.89 | 3.190 | ..... | 1.070 | ..... | |
| Helenwood | 54.240 | 41.29 | 2.640 | ..... | 1.830 | ..... | |
| Jellico | 60.600 | 36.44 | 1.600 | 1.160 | 2.360 | ..... | Dr. Peter. |
| Poplar Creek | 56.120 | 39.33 | 2.810 | ..... | 1.240 | ..... | Regis Chauvenet. |
| Crooke Coal and Coke Company. | 61.660 | 34.53 | 2.140 | 0.088 | 1.670 | 0.017 | Furnished by Mr. H. S. Chamberlain, president Roane Iron Company. No analysis given. |
| Roane Iron Company (Rockwood). | 60.110 | 26.62 | 11.520 | 1.049 | 1.750 | ..... | |
| Roane Iron Company | 60.750 | 32.59 | 5.270 | ..... | 1.390 | ..... | |
| Stanley (near Chattanooga) | 61.730 | 26.70 | 10.210 | 0.530 | 1.360 | ..... | |
| Sewanee (Tracy mines) | 62.000 | 25.41 | 10.820 | ..... | 1.770 | ..... | Robertson. |
| Do | 63.500 | 29.90 | 6.600 | Trace. | ..... | ..... | H. T. Yaryan. |
| Soddy mines (Sewanee seam) | 64.390 | 27.82 | 6.640 | ..... | 1.150 | ..... | |
| Emery mines (Sewanee seam) | 63.100 | 27.70 | 7.700 | 0.530 | 0.150 | ..... | Prof. T.E. Wormley. |
| Etna mines (Kelly seam) | 74.200 | 21.39 | 2.700 | 0.700 | 1.300 | 0.005 | McCreath & Pohle. |

*Analyses of Tennessee cokes.*

| Name of coal. | Fixed carbon. | Ash. | Sulphur. | Moisture. | Phosphorus. | |
|---|---|---|---|---|---|---|
| Sewanee seam (Tracy City) | 83.364 | 15.440 | 0.142 | ..... | ..... | W. J. Land. |
| Etna (Kelly) | 94.560 | 4.650 | 0.790 | ..... | 0.008 | University of Cincinnati. |
| Rockwood | 84.187 | 14.141 | 0.182 | ..... | ..... | W. J. Land. |
| Dayton | 84.150 | 14.880 | ..... | ..... | ..... | |
| Poplar Creek | 90.060 | 5.000 | 0.570 | 0.010 | 0.010 | Potter & Riggs. |
| Do | 95.240 | 4.760 | ..... | ..... | ..... | Regis Chauvenet. |

## TEXAS.

It is estimated that the production of the coal mines of the State for 1885 was 150,000 tons. No detailed statistics are collected by any of the State departments upon which a more exact estimate can be based.

It is said that coal exists in 33 counties. Outside of the coal which has been worked in a small way for local use, mining has been confined to Webb, Milan, and Bexar counties. In the vicinity of Laredo, on the Rio Grande, extensive mines have been opened. The coal beds, however, are thin, being only 18 and 26 inches thick respectively. There is a report, however, that a coal bed exists beneath these two, which is 50 inches thick. Mining has been paid for at the rate of $1.50 per ton.

These mines being near the Rio Grande, it would appear that their production must still increase. The Rio Grande and Pecos railroad has recently been built and several coal mines have been opened along

the line of the road, about 25 miles west of the city of Laredo. At Santo Tomas, 29 miles from Laredo, a mine is worked where the seam of coal is reported to be 30 inches in thickness.

In a report on the Brazos coal field, by Mr. C. A. Ashburner, geologist in charge of the Pennsylvania survey, he says:

"Coal has been reported to have been found in El Paso and Presidio counties along the Rio Grande, but nothing has been authentically stated as to the extent of the areas or the value of the beds.

"Tertiary lignites, or lignitic coals, are said to exist in the following counties: Rush, Harrison, Cass, Grayson, Bastrop, Fayette, Caldwell, and Guadalupe.

"The Brazos coal field is the southwestern limit of the Missourian or fourth bituminous coal basin of the United States. The coal measures of Stephens and Young counties belong to the Carboniferous age. The coal strata proper are 85 feet thick, and are included between an upper sandstone and conglomerate, representative of the Millstone grit or Pottsville conglomerate, No. XII. of the Pennsylvania series, and a lower gray limestone representative of the Mountain limestone or Chester and Saint Louis limestone of the Mississippi valley. The coal strata contain two coal beds of workable thickness. The upper bed, named Belknap, ranges from 2½ to 4 feet, and the lower, named Brazos, from 4 to 6 feet. The coals are high in ash and sulphur, but have never been thoroughly tested. The Brazos bed underlies a great area and will no doubt prove to be a valuable commercial coal in some localities."

## UTAH.

The coal production of the Territory for the year was 213,120 tons, the bulk of which was mined from the San Pete County coal beds, located chiefly in Pleasant valley. This is bituminous coal of a fair quality, and has within the past two years taken the place, in the Utah market, of the Wyoming coals. The remainder of the coal product comes from the Grass Creek and Weber mines, in Summit county, the latter being owned by the Home Coal Company.

*Product by companies.*

| Name. | Tons. |
|---|---|
| Pleasant Valley Coal Company | 78,996 |
| Utah Central Coal Company | 42,865 |
| San Pete Coal and Coke Company | 17,000 |
| Grass Creek Coal Company | 52,000 |
| Home Coal Company | 22,259 |
| Total | 213,120 |

The Pleasant Valley company has four coal beds opened, three of them being at Winter Quarters and one at Mud creek on the line of the Denver and Rio Grande Western railway, and the product of these mines

has been shipped to the coal mines, to the railroad company, and to the towns along the line of the road which reaches them, at an average cost of $5 per ton. The company employs an average of 150 men and pay 70 and 80 cents for breaking the coal, which is worth $2 per ton delivered on the cars.

The Utah Central company, whose mines are also located in Pleasant valley, finds a domestic ("house") market for all of its product. It employed an average of 75 men during the year, paid 70 and 80 cents for mining, and delivered its coal on the cars at $2 per ton.

The San Pete Coal and Coke Company, with its own road, 30 miles long, tapping its mines and connecting with the Utah Central railroad, has been unable to compete in the market with the other companies, because it is not owned and controlled by one of the large railroad companies, and is therefore kept out of the coal pool.

The Grass Creek mines are operated by the Union Pacific Coal Company, and the entire product of these mines is consumed in Utah. Twenty men are employed, and the price paid for breaking the coal is the same as in the Pleasant Valley mines. In the market this coal is known as the "Weber."

The Home Coal Company pays 90 cents per ton for mining, and loads its coal on cars for $2. The whole product of this company is shipped to Park City, in Summit county, where the bulk of it is used at the Ontario stamp mill.

A small amount of Colorado hard coal finds a market in Utah, while Wyoming continues to supply about one-fourth of the coal consumed in the Territory.

## VIRGINIA.

According to Maj. Jed. Hotchkiss, the production of coal in the State for 1885 was as follows:

*Production of coal in Virginia in* 1885.

| | Short tons. |
|---|---|
| 1. Semi-bituminous coking and steam coal, from Pocahontas mines, Tazewell county | 511,575 |
| 2. Bituminous coal from Richmond basin, Chesterfield, Powhatan, and Henrico counties, about | 50,000 |
| 3. Mines, in Vespertine (No. X.) anthracite, semi-anthracite, &c., mainly in southwest valley of Virginia, about | 5,000 |
| 4. Bituminous coal, for local use, in Appalachian region of southwest Virginia, about | 425 |
| Total production | 567,000 |

The coal mined from the Richmond basin occurs in the Triassic formation. Very thin seams (1 inch, more or less) of coal have recently been found in this same geological formation in the vicinity of Phœnixville, Pennsylvania. The Deep River and Dan River coal beds in North Carolina are found in the same Triassic formation.

## WASHINGTON TERRITORY.

The coal of the Territory comprises its principal mineral resource. Outcrops of coal occur in almost every portion of western Washington, indicating its general distribution. On the Columbia river lignite or brown coal appears in thin seams, extending continuously northward; the quality improving toward the north. The experience of a quarter of a century demonstrates the value of Washington Territory coal for economical and commercial purposes; its mines have been profitably worked, and its coals rank among the best on the Pacific slope.

In the fall of 1852 coal was discovered on Bellingham bay. From the first mines 150 tons were shipped to San Francisco. The mine of the Bellingham Bay company was discovered in 1853, and opened the succeeding year. The San Francisco company which operated this mine continued the only exporter of coal from the Territory down to 1870. In 1871 the exportation of coal commenced at Seattle. As early as 1854, coal mining had been pursued on Black river by Dr. Bigelow, but to no great extent. Concerning the coal mines the *Oregonian* says: "The Seattle, Renton, and Talbot mines are in the vicinity of Seattle. The coal of all these mines is of the lignite variety, well adapted to steam and domestic purposes. The Seattle mine was discovered in 1866 by R. H. Lewis, who sold it for $30,000. The first shipment of coal was made to San Francisco in 1870, on the bark Moneyick, consisting of 405 tons. In 1874 the product was 50,000 tons; from July 1, 1878, to July 1, 1879, 155,900 tons. During the year ending December 31, 1879, 137,207 tons of coal were produced. In 1874 the Renton mine was opened, producing during 1875 and 1876 25,000 tons of coal annually. The Talbot mine, opened in 1875, produced, in 1879, 18,000 tons of coal."

The mining of coal is at present confined to King and Pierce counties. From January 1, 1884, to November 1, 1885, the King County coal mines yielded 413,315 tons. From January 1, 1884, to July 1, 1885, the Pierce county mines yielded 267,884 tons. From that date the Pierce county mines reduced their export until December, 1885.

The output of coal from Washington Territory mines during the year ended June 30, 1885, was 380,250 tons, from the following mines: Newcastle, 149,048; Renton, 30,397; Cedar River, 14,573; Black Diamond, 10,562; Carbon Hill, 135,926; South Prairie, 34,313; Tacoma, 5,431. The Newcastle, Renton, Cedar River, and Black Diamond mines are in King county; the Carbon Hill, South Prairie, and Tacoma mines in Pierce. During the year 1885, the *Oregonian* says, the King County mines yielded 204,480 tons; the Pierce county mines 175,770. The Cedar River and Black Diamond are new mines, the others are old ones. During the year 1886 the new Franklin mine will swell the production of King county coal.

About 2,500,000 tons of coal have thus far been mined in Washington Territory, 1,700,000 of which were from the mines of King county;

about half of the remainder from Pierce county, and the other half from Whatcom.

## WEST VIRGINIA.

The following estimate of the coal production has been carefully made by H. J. Tucker, inspector of mines, from the most reliable data obtainable, and it is believed that it does not differ materially from the true amount. An effort was made to obtain from each operator a statement of the output of his mine, but in several cases such statements were not furnished. The production of such mines as failed to report have, however, been estimated and included in the totals.

There are a number of small mines in the State employing about ten or less miners each, from which the returns were too meager to make even an estimate of their production, and they were not considered in the calculation.

| | Long tons. | |
|---|---|---|
| Output of the mines on the West Virginia and Pennsylvania railroad | 400,035 | |
| Output of the mines in the northern part of the State, including the mines of Mason county | 645,500 | |
| Total output of the northern part of the State | | 1,045,535 |
| Output of the Flat Top (Mercer county) mines | 147,484 | |
| Output of the Kanawha and New River mines | 1,815,072 | |
| Total output of the southern part of the State | | 1,962,556 |
| Total | | 3,008,091 |

*Coke production in West Virginia in* 1885.

| | |
|---|---|
| Coke produced in the northern part of the State | 54,671 |
| Coke produced in the southern part of the State | 112,846 |
| Total | 167,517 |

The following is an official statement of the coal and coke tonnage of the Chesapeake and Ohio railway during the year:

| Kind of coal: | Short tons. | |
|---|---|---|
| Cannel | 29,260 | |
| Gas | 298,251 | |
| Splint and block | 101,315 | |
| New River | 526,182 | |
| Total quantity of coal | | 965,008 |
| Coke | | 112,843 |
| Total quantity of coal and coke | | 1,077,851 |

## WYOMING.

No new coal field was opened in Wyoming during 1885. The amount of coal produced was not as great as in 1884, due to the disastrous strikes, arising from the Chinese riots at the Rock Spring mine in September. As a result of this strike, the product of the Colorado Coal and Iron Company's mines was increased by nearly 1,000 tons per day,

sold to the Union Pacific railroad in Colorado during the strike, while a correspondingly large demand was made upon the Iowa coal mines to supply the Nebraska divisions of the road.

Many new openings of coal have been made, but their distance from railways and the want of superiority of the coal to that at the opened coal mines, has prevented any development.

The production of the various mines in Wyoming from the time of opening to the close of the year 1885 has been as follows:

*Product of the Carbon mines, Wyoming.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1868 | 6,560 | 1877 | 74,343 |
| 1869 | 30,482 | 1878 | 62,418 |
| 1870 | 54,915 | 1879 | 75,424 |
| 1871 | 31,748 | 1880 | 100,433 |
| 1872 | 59,237 | 1881 | 156,820 |
| 1873 | 61,164 | 1882 | 200,123 |
| 1874 | 55,880 | 1883 | 248,380 |
| 1875 | 61,750 | 1884 | 319,883 |
| 1876 | 69,060 | 1885 | 226,863 |

*Product of the Rock Spring mines, Wyoming.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1868 | 365 | 1877 | 146,494 |
| 1869 | 16,933 | 1878 | 154,282 |
| 1870 | 20,945 | 1879 | 193,252 |
| 1871 | 40,566 | 1880 | 244,460 |
| 1872 | 34,677 | 1881 | 270,425 |
| 1873 | 44,700 | 1882 | 287,510 |
| 1874 | 58,476 | 1883 | 304,495 |
| 1875 | 104,664 | 1884 | 318,197 |
| 1876 | 134,952 | 1885 | 328,601 |

*Product of the Union Pacific mines at Almy, Wyoming.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1869 | 1,967 | 1878 | 59,096 |
| 1870 | 12,454 | 1879 | 71,576 |
| 1871 | 21,171 | 1880 | 100,234 |
| 1872 | 22,713 | 1881 | 110,157 |
| 1873 | 22,847 | 1882 | 117,211 |
| 1874 | 23,006 | 1883 | 111,713 |
| 1875 | 41,805 | 1884 | 150,880 |
| 1876 | 60,756 | 1885 | 164,441 |
| 1877 | 54,643 | | |

*Product of the Central Pacific mines at Almy, Wyoming.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1870 | 16,981 | 1878 | 57,404 |
| 1871 | 53,843 | 1879 | 60,739 |
| 1872 | 105,118 | 1880 | 82,684 |
| 1873 | 130,989 | 1881 | 90,779 |
| 1874 | 181,699 | 1882 | 94,065 |
| 1875 | 92,589 | 1883 | 78,450 |
| 1876 | 69,782 | 1884 | 68,471 |
| 1877 | 67,373 | 1885 | 70,216 |

The Twin Creek mine was worked for a short time only during 1885. The coal from this mine is much inferior to that from Rock Spring and Almy, containing large quantities of water and ash. The product at this mine has been as follows:

| | Short tons. |
|---|---|
| 1882 | 8,855 |
| 1883 | 36,651 |
| 1884 | 45,189 |
| 1885 | 17,207 |

RECAPITULATION.

| Years. | Carbon. | Rock Spring. | Almy. | | Twin Creek. | Total. |
|---|---|---|---|---|---|---|
| | | | Union Pacific mines. | Central Pacific mines. | | |
| | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| 1868 | 6,560 | 365 | ..... | ..... | ..... | 6,925 |
| 1869 | 30,482 | 16,933 | 1,967 | ..... | ..... | 49,382 |
| 1870 | 54,915 | 20,945 | 12,454 | 16,981 | ..... | 105,295 |
| 1871 | 31,748 | 40,566 | 21,171 | 53,843 | ..... | 147,328 |
| 1872 | 59,237 | 34,677 | 22,713 | 105,118 | ..... | 221,745 |
| 1873 | 61,164 | 44,700 | 22,847 | 130,989 | ..... | 259,700 |
| 1874 | 55,880 | 58,476 | 23,006 | 81,699 | ..... | 219,061 |
| 1875 | 61,750 | 104,664 | 41,805 | 92,589 | ..... | 300,808 |
| 1876 | 69,060 | 134.952 | 60,756 | 69,782 | ..... | 334,550 |
| 1877 | 74,343 | 146,494 | 54,643 | 67,373 | ..... | 342,853 |
| 1878 | 62,418 | 154,282 | 59,096 | 57,404 | ..... | 333,200 |
| 1879 | 75,424 | 193,252 | 71,576 | 60,739 | ..... | 400,991 |
| 1880 | 100,433 | 244,460 | 100,254 | 82,684 | ..... | 527,811 |
| 1881 | 156,820 | 270,425 | 110,157 | 90,779 | ..... | 628,181 |
| 1882 | 200,123 | 287,510 | 117,211 | 94,065 | 8,855 | 707,764 |
| 1883 | 248,380 | 304,495 | 111,713 | 78,450 | 36,651 | 779,689 |
| 1884 | 319,883 | 318,197 | 150,880 | 68,471 | 45,189 | 902,620 |
| 1885 | 226,863 | 328,601 | 164,441 | 70,216 | 17,207 | 807,328 |

The number of employés in the coal mines varies greatly from summer to winter. The greatest number of men employed is about 1,100. The wages paid vary from 90 cents to $1.10 per ton of coal. The value of the product of the Territory in 1885 at $3 per ton is $2,421,984.

# THE MANUFACTURE OF COKE.

By Joseph D. Weeks.

The same restricted use of the word "coke" that has prevailed in previous reports obtains in this as well. The only coke reported upon is that made from bituminous coal in ovens, pits, ricks, or "on the ground," and which, for convenience, may be termed "oven coke." No attempt was made to gather the statistics of "gas coke," or that which is the residual product of the manufacture of gas.

The unit of quantity throughout this chapter is the short ton of 2,000 pounds.

The measures of the great Appalachian basin still furnish by far the largest proportion of the coal used in the manufacture of coke in the United States. Of the 8,071,126 tons of coal burned into coke in 1885 but 283,070 tons, or about 3 per cent., came from other coal fields. Of this 283,070 tons, 239,958 tons were from what may be termed the Colorado basin, including the coal fields of Colorado and New Mexico; 21,487 tons from the Illinois basin; 20,781 tons from the Missouri basin, which would include that used in Kansas and the Indian Territory; 544 tons from Washington Territory, and 300 tons from Montana. It will thus appear that all of the coal used in the manufacture of coke in the United States, with the exception of less than 50,000 tons, came from the Appalachian and Colorado coal fields.

In the production of coke Pennsylvania still stands the first, 3,991,805 tons, or 78 per cent. of the 5,106,696 tons produced in the United States coming from its ovens. As will also appear from an examination of the details of the manufacture of coke in this State, several of its coking districts produce a greater tonnage than most of the States, at least two of the ten coking districts into which it is divided, the Connellsville and the Irwin Latrobe, each producing an amount in excess of that produced in any State except Pennsylvania. Of these districts the most important not only in Pennsylvania, but in the United States, is the Connellsville, a small trough some 50 or 60 miles long by 3 miles wide. In the Connellsville region 3,096,012 tons of the 5,106,696 tons, or 61 per cent. of the coke produced in the United States in 1885, was made. In the Irwin-Latrobe district, which includes the ovens along the line of the Pennsylvania railroad from Larimer to Blairsville, 319,297 tons of coke were produced.

Two of the districts in Pennsylvania have shown a marked increase during the past year in the production of coke, notwithstanding the general depression in trade. These are the Allegheny Mountain district and what is called in this report, the Reynoldsville-Walston. The production in the Allegheny Mountain district increased from 156,290 tons in 1884 to 212,242 tons in 1885, an increase of more than one-third; the production in the Reynoldsville-Walston district increased from 78,646 tons in 1884 to 114,409 tons in 1885, an increase of over 50 per cent. In no coking district in the country has there been such a growth in the past year, or such promise of growth for 1886 as in the last-named district. It will also appear from an inspection of the tables, given in connection with the other districts of Pennsylvania, that there has been a marked increase in production in the Snow Shoe district, but this is not at present as important as the others named.

Going southwardly there has been a gratifying increase in production in West Virginia, the amount of coke made increasing from 223,472 tons in 1884 to 260,571 tons in 1885, making last year's production some 3,000 tons in excess of the largest amount in any previous year. Should the developments in the Bluestone region fulfill their promise, this production may be largely increased during 1886.

The production of coke in Alabama is also the largest known in the history of its coke industry, it being 301,180 tons in 1885 as compared with 244,009 tons in 1884. Indeed, an inspection of the table of production will show that every year since 1880 has been marked by an increase in the production of coke in Alabama and that this is the only State of any prominence that has shown progress each year during this period.

In Ohio, Virginia, and Georgia, the other States in the Appalachian coal basin which produce coke, there has been a falling off in production during 1885 as compared with 1884.

But little need be said about the production of coke in the coal fields outside of the Appalachian. The production in the Colorado coal field, including in this field the ovens of Colorado and New Mexico, shows a slight increase, there being an increase of some 16,000 tons in Colorado, while that of New Mexico is about the same as in 1884. There has been a slight increase in the production of coke in the Missouri basin and a decrease in the production in the Illinois basin and in Washington Territory, but these districts are of but little moment at present.

*Statistics of coking in the United States.*—In the following table are consolidated the statistics of coking in the United States for the years 1880 to 1885. These relate not only to the production and value of coke, but also to the consumption of coal and its percentage yield in coke, as well as the number of establishments making coke, and the number of ovens built and building at the close of each year.

*Statistics of the manufacture of coke in the United States, 1880 to 1885, inclusive.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 186 | 197 | 215 | 231 | 250 | 233 |
| Ovens built | 12,372 | 14,119 | 16,356 | 18,304 | 19,557 | 20,116 |
| Ovens building | 1,159 | 1,005 | 712 | 407 | 812 | 432 |
| Coal used, short tons | 5,237,741 | 6,546,662 | 7,577,648 | 8,516,670 | 7,951,974 | 8,071,126 |
| Coke produced, short tons | 3,338,300 | 4,113,760 | 4,793,321 | 5,464,721 | 4,873,805 | 5,106,696 |
| Total value of coke at ovens | $6,631,267 | $7,725,175 | $8,462,167 | $8,121,607 | $7,242,878 | $7,629,118 |
| Value of coke at ovens, per ton | $1.99 | $1.88 | $1.77 | $1.49 | $1.49 | $1.49 |
| Yield of coal in coke, per cent | 63 | 63 | 63 | 64 | 61 | 63 |

From this table it appears that the number of establishments has increased in the six years covered by the report from 186 to 233; the number of ovens built from 12,372 to 20,116; the production of coke from 3,338,300 short tons to 5,106,696 short tons, and the coal consumed in the manufacture of the same, from 5,237,741 short tons to 8,071,126 short tons; the total value of the coke has increased from $6,631,267 to $7,629,118, but the average value per ton has decreased from $1.99 to $1.49, or 25 per cent.

While there has been this marked increase from 1880 to 1885 in all the items included in this table, except the average value of the coke per ton, the year 1885 is by no means the year of the highest production in the series. In 1883 the amount of coke produced, its total value, and the amount of coal consumed in its production were greater than during any other year before or since. The indications are that 1886 will show a production in excess of 1883.

*Total number of coke works in the United States.*—The following table gives the total number of establishments manufacturing coke in the United States at the close of each year from 1880 to 1885, inclusive. In this classification each separate coke works with its ovens and other associated plant is regarded as a separate establishment. In several instances, especially in the Connellsville coke region, it was found that an individual or a firm operated several contiguous coke works; while in other cases two or more works, operated by the same parties, were widely separated. Notwithstanding this ownership by the same party of more than one bank of ovens, each bank is regarded as an establishment, and is so classified. It has been difficult, in some cases, to determine whether ovens operated by the same owner on adjoining properties should be classified as one or more establishments. In such cases we have taken the report of the owner. The number of works, therefore, and the numbers of separate firms or owners are not the same.

*Number of establishments in the United States manufacturing coke, from* 1880 *to* 1885.

| States and Territories. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Alabama | a 4 | 4 | 5 | 6 | 8 | 11 |
| Colorado | 1 | 2 | 5 | 7 | 8 | 7 |
| Georgia | 1 | 1 | 1 | 1 | 1 | 2 |
| Illinois | 6 | 6 | 7 | 7 | 9 | 9 |
| Indiana | 2 | 2 | 2 | 2 | 2 | 2 |
| Ind.an Territory | 1 | 1 | 1 | 1 | 1 | 1 |
| Kansas | 2 | 3 | 3 | 4 | 4 | 4 |
| Kentucky | 5 | 5 | 5 | 5 | 5 | 5 |
| Montana | 0 | 0 | 0 | 1 | 3 | 2 |
| New Mexico | 0 | 0 | 2 | 2 | 2 | 2 |
| Ohio | 15 | 15 | 16 | 18 | 19 | 13 |
| Pennsylvania | 124 | 132 | 137 | 140 | 145 | 133 |
| Tennessee | 6 | 6 | 8 | 11 | 13 | 12 |
| Utah | 1 | 1 | 1 | 1 | 1 | 1 |
| Virginia | 0 | 0 | 0 | 1 | 1 | 1 |
| Washington | 0 | 0 | 0 | 0 | 1 | 1 |
| West Virginia | 18 | 19 | 22 | 24 | 27 | 27 |
| Total | 186 | 197 | 215 | 231 | 250 | 233 |

a The number of establishments is the number December 31 of each year.

It will be noted from the above table that there has been a falling off in the total number of works at the close of 1885 as compared with the number at the close of 1884. This is due in part to the consolidation of works which in previous reports were regarded as separate establishments, but now are reported by their owners as one. In addition to these consolidations quite a number of works of but little importance, and usually in districts of but little rank as coke-producing centers, have passed out of existence. The chief reduction in the number of works is in Ohio and Pennsylvania, the number of establishments in the former State having been reduced from nineteen in 1884 to ten in 1885. The reduction in this State is chiefly due to the abandonment of works. In Pennsylvania the number of establishments has been reduced from 145 to 133. This reduction is due to both of the causes above named.

The number of establishments in the country for the years since 1850, for which there are any returns, was as follows:

| Years. | Number. | Years. | Number. |
|---|---|---|---|
| 1850 (census year) | 4 | 1881, December 31 | 197 |
| 1860 (census year) | 21 | 1882, December 31 | 215 |
| 1870 (census year) | 25 | 1883, December 31 | 231 |
| 1880 (census year) | 149 | 1884, December 31 | 250 |
| 1880, December 31 | 186 | 1885, December 31 | 233 |

*Total number of coke ovens in the United States.*—The following table gives the total number of coke ovens in the United States on December 31 of each of the years from 1880 to 1885, and also their distribution by States and Territories. In addition to the coke made in ovens some has been made in pits and on the ground, but as the number of pits varies greatly at different times, no attempt has been made to give their total number. The reports also show that much less "pit coke"

was made in 1885 than in any of the previous years for which reports are given.

*Number of coke ovens in the United States on December 31 of each of the years from 1880 to 1885.*

| States and Territories. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Alabama | 316 | 416 | 536 | 767 | 976 | 1,075 |
| Colorado | 200 | 267 | 344 | 352 | 409 | 434 |
| Georgia | 140 | 180 | 220 | 264 | 300 | 300 |
| Illinois | 176 | 176 | 304 | 316 | 325 | 320 |
| Indiana | 45 | 45 | 37 | 37 | 37 | 37 |
| Indian Territory | 20 | 20 | 20 | 20 | 20 | 40 |
| Kansas | 6 | 15 | 20 | 23 | 23 | 23 |
| Kentucky | 45 | 45 | 45 | 45 | 45 | 33 |
| Montana | 0 | 0 | 0 | 2 | 5 | 2 |
| New Mexico | 0 | 0 | 0 | 12 | 70 | 70 |
| Ohio | 616 | 641 | 647 | 682 | 732 | 642 |
| Pennsylvania | 9,501 | 10,881 | 12,424 | 13,610 | 14,285 | 14,553 |
| Tennessee | 656 | 724 | 861 | 992 | 1,105 | 1,387 |
| Utah | 20 | 20 | 20 | 20 | 20 | 20 |
| Virginia | 0 | 0 | 0 | 200 | 200 | 200 |
| Washington | 0 | 0 | 0 | 0 | 0 | 2 |
| West Virginia | 631 | 689 | 878 | 962 | 1,005 | 978 |
| Total | 12,372 | 14,119 | 16,356 | 18,304 | 19,557 | 20,116 |

The number of coke ovens in the United States has increased during the year 1885 from 19,557, the number reported at the close of 1884, to 20,116. This increase is a small percentage, but it shows a gradual enlargement of the capacity of the country for the manufacture of coke. It will also be noted that in each of the years for which reports are given there has been an increase in the total number of ovens in existence over that of previous years.

The States having more than 1,000 ovens each in 1885 are Pennsylvania, with 14,553, or 76 per cent. of the total; Tennessee, with 1,387, or 6.9 per cent. of the total; and Alabama, with 1,075, or 5.3 per cent. of the total. West Virginia, which in 1884 had 5 over a thousand, now reports but 978, the relative position of this State and Alabama in respect to the number of ovens having changed.

Most of the ovens in use in the United States are of the beehive pattern, or a somewhat modified form of the beehive, known as the "drag," chiefly the former. The Belgian oven is held in much less favor in this country than formerly. Two quite large blocks of these ovens in western Pennsylvania that were reported in 1884 are now abandoned. At two other works in the same State where Belgian ovens have been built and tried, though the flue ovens have not been abandoned entirely, the new construction of the past two years has been of the beehive pattern. It is but fair to say, however, that with some West Virginia coal, the Belgian oven of the Soldenhof-Coppeé type, a bank of which is in operation at Hawk's Nest, is looked upon with favor. Mr. J. H. Bramwell, the mining engineer of the Bluestone Coal company, is of the opinion that this oven is well adapted to the coking of the coal from the Bluestone field. As yet no ovens of the Simon-Carvés type, or those adapted to

the recovery of the waste products of combustion, have been built in this country, though some experiments have been made in coking American coal in them in England. The results of these experiments were fairly satisfactory, as far as relates to the recovery of the products and the yield of coke, but it was believed that the oven was too expensive in its first cost and possibly in its repairs to adapt it to economical use in view of the conditions prevailing in American coke fields.

*Number of ovens building in the United States.*—In the following table is given the number of ovens that were actually in course of construction in the United States at the close of each of the years from 1880 to 1885:

*Number of coke ovens building in the United States at the close of each of the years from 1880 to 1885.*

| States and Territories. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Alabama | 100 | 120 | 0 | 122 | 242 | 16 |
| Colorado | 50 | 0 | 0 | 0 | 24 | 0 |
| Georgia | 40 | 40 | 44 | 36 | 0 | 0 |
| Illinois | 0 | 0 | 0 | 0 | 0 | 0 |
| Indiana | 0 | 0 | 0 | 0 | 0 | 0 |
| Indian Territory | 0 | 0 | 0 | 0 | 0 | 0 |
| Kansas | 0 | 0 | 0 | 0 | 0 | 0 |
| Kentucky | 0 | 0 | 0 | 0 | 0 | 0 |
| Montana | 0 | 0 | 0 | 0 | 12 | 0 |
| New Mexico | 0 | 0 | 12 | 28 | 0 | 0 |
| Ohio | 25 | 0 | 0 | 0 | 0 | 0 |
| Pennsylvania | 836 | 761 | 642 | 211 | 232 | 317 |
| Tennessee | 68 | 84 | 14 | 10 | 175 | 36 |
| Utah | 0 | 0 | 0 | 0 | 0 | 0 |
| Virginia | 0 | 0 | 0 | 0 | 0 | 0 |
| Washington | 0 | 0 | 0 | 0 | 0 | 0 |
| West Virginia | 40 | 0 | 0 | 0 | 127 | 63 |
| Total | 1,159 | 1,005 | 712 | 407 | 812 | 432 |

There is no attempt in this table to show the increase in the total number of ovens, but only those building at the close of the year. The construction of ovens may have been undertaken and completed during the year, but this would not be shown in this table, but in the previous one, giving the total number of ovens at the close of the year. This table indicates in a slight degree the prospects of the industry at the close of the year. At the close of 1883, for example, there was but little encouragement for the building of works, and as a result there were but few ovens in course of construction when the report closed, December 31. At the close of 1880, however, the conditions were different and nearly three times as many were building. The close of 1885 finds about the same number building as at the close of 1883. Most of these are in Pennsylvania.

*Total production of coke in the United States.*—The production of coke in the United States for the years 1880 to 1885, inclusive, was as follows:

*Amount of coke produced in the United States, 1880 to 1885, inclusive, by States and Territories.*

| States and Territories. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Shorttons.* |
| Alabama | 60,781 | 109,033 | 152,940 | 217,531 | 244,009 | 301,180 |
| Colorado | 25,568 | 48,587 | 102,105 | 133,997 | 115,719 | 131,960 |
| Georgia | 38,041 | 41,376 | 46,602 | 67,012 | 79,268 | 76,669 |
| Illinois | 12,700 | 14,800 | 11,400 | 13,400 | 13,095 | 10,350 |
| Indian Territory | 1,546 | 1,768 | 2,025 | 2,573 | 1,912 | 3,584 |
| Kansas | 3,070 | 5,670 | 6,080 | 8,430 | 7,190 | 8,050 |
| Kentucky | 4,250 | 4,370 | 4,070 | 5,025 | 2,223 | 2,704 |
| Montana | 0 | 0 | 0 | 0 | 75 | 175 |
| New Mexico | 0 | 0 | 1,000 | 3,905 | 18,282 | 17,940 |
| Ohio | 100,596 | 119,469 | 103,722 | 87,834 | 62,709 | 39,416 |
| Pennsylvania | 2,821,384 | 3,437,708 | 3,945,034 | 4,438,464 | 3,822,128 | 3,991,805 |
| Tennessee | 130,609 | 143,853 | 187,695 | 203,691 | 219.723 | 218,842 |
| Utah | 1,000 | 0 | 250 | 0 | 0 | 0 |
| Virginia | 0 | 0 | 0 | 25,340 | 63,600 | 49,139 |
| Washington | 0 | 0 | 0 | 0 | 400 | 311 |
| West Virginia | 138,755 | 187,126 | 230,398 | 257,519 | 223,472 | 260,571 |
| Total | 3,338,300 | 4,113,760 | 4,793,321 | 5,464,721 | 4,873,805 | 5,106,696 |

The maximum production of coke in the United States was reached in 1883, when 5,464,721 tons were made. This declined in 1884 to 4,873,805 tons. The production of 1885 shows a gain upon that of 1884, the make in this year being 5,106,696 tons, or within less than 360,000 tons of the make in 1883.

Since coking became an industry in this country the bulk of the coke produced has been from the coals of Pennsylvania. The production of this State in 1884 was 78.4 per cent., in 1885 its production was 3,991,805 tons, or 78.2 per cent. of the total of 5,106,696 tons, showing a slight falling off during the past year in its percentage.

The following table gives the relative rank of the States and Territories in the production of coke in 1884 and 1885:

*Rank of the States and Territories in production of coke in 1884 and 1885.*

| States and Territories. | 1884. | 1885. |
|---|---|---|
| Pennsylvania | 1 | 1 |
| Alabama | 2 | 2 |
| West Virginia | 3 | 3 |
| Tennessee | 4 | 4 |
| Colorado | 5 | 5 |
| Georgia | 6 | 6 |
| Virginia | 7 | 7 |
| Ohio | 8 | 8 |
| New Mexico | 9 | 9 |
| Illinois | 10 | 10 |
| Kansas | 11 | 11 |
| Kentucky | 12 | 13 |
| Indian Territory | 13 | 12 |
| Washington | 14 | 14 |
| Montana | 15 | 15 |

The only changes are that Kentucky has dropped from the twelfth to the thirteenth place, and the Indian Territory, which occupied the thirteenth place in 1884, has risen to the twelfth.

*Value and average selling price of coke.*—In the following table are given the total value of coke produced in the United States and its average selling price per ton for each of the years from 1880 to 1885:

*Total value at the ovens of the coke made in the United States in the years from* 1880 *to* 1885, *by States and Territories.*

| States and Territories. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Alabama | $183,063 | $326,819 | $425,940 | $598,473 | $609,185 | $755,645 |
| Colorado | 145,226 | 267,156 | 476,665 | 584,578 | 409,930 | 512,162 |
| Georgia | 81,789 | 88,753 | 100,194 | 147,166 | 169,192 | 144,198 |
| Illinois | 41,950 | 45,850 | 29,050 | 28,200 | 25,639 | 27,798 |
| Indiana | 0 | 0 | 0 | 0 | 0 | 0 |
| Indian Territory | 4,638 | 5,304 | 6,075 | 7,719 | 5,736 | 12,902 |
| Kansas | 6,000 | 10,200 | 11,460 | 16,560 | 14,580 | 13,255 |
| Kentucky | 12,250 | 12,630 | 11,530 | 14,425 | 8,760 | 8,499 |
| Montana | 0 | 0 | 0 | 0 | 900 | 2,063 |
| New Mexico | 0 | 0 | 6,000 | 21,478 | 91,410 | 89,700 |
| Ohio | 255,905 | 297,728 | 266,113 | 225,660 | 156,291 | 109,723 |
| Pennsylvania | 5,255,042 | 5,898,579 | 6,133,698 | 5,410,387 | 4,783,250 | 4,981,656 |
| Tennessee | 316,607 | 342,585 | 472,505 | 459,126 | 428,870 | 398,459 |
| Utah | 10,000 | 0 | 2,500 | 0 | 0 | 0 |
| Virginia | 0 | 0 | 0 | 44,345 | 111,300 | 85,993 |
| Washington | 0 | 0 | 0 | 0 | 1,900 | 1,477 |
| West Virginia | 318,797 | 429,571 | 520,437 | 563,490 | 425,952 | 485,588 |
| Total | 6,631,267 | 7,725,175 | 8,462,167 | 8,121,607 | 7,242,878 | 7,629,118 |

While this table gives the totals of the values as returned in the schedules, the figures do not always represent the same thing. A statement as to the actual selling price of coke at the ovens was asked for, and in most cases, including, possibly, 80 per cent. of all the coke produced, the figures are actual selling prices. In some cases, however, the value is an estimate. Considerable of the coke made in the United States is produced by the proprietors of blast furnaces for consumption in their own furnaces, none being sold. The value, therefore, given for this coke would be an estimate based, in some instances, where there are coke works in the neighborhood selling coke for the general market, upon the prices obtained for this coke. In other cases the value is estimated at the actual cost of coke at the furnace plus a small percentage for profit on the coking operation, while in still other cases the value given is only the actual cost of the coke at the ovens.

The preceding table gives the total value of the coke by States and Territories and also for the United States. In the following table is given the average value per short ton:

*Average value per short ton at the ovens of the coke made in the United States in the years from 1880 to 1885, by States and Territories.*

| States and Territories. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Alabama | $3 01 | $3 00 | $2 79 | $2 75 | $2 50 | $2 50 |
| Colorado | 5 68 | 5 29 | 4 67 | 4 36 | 3 45 | 3 88 |
| Georgia | 2 15 | 2 15 | 2 15 | 2 20 | 2 13 | 2 04 |
| Illinois | 3 30 | 3 10 | 2 55 | 2 10 | 1 96 | 2 68 |
| Indiana | 0 | 0 | 0 | 0 | 0 | 0 |
| Indian Territory | 3 00 | 3 00 | 3 00 | 3 00 | 3 00 | 3 60 |
| Kansas | 1 95 | 1 80 | 1 70 | 1 96 | 2 02 | 1 65 |
| Kentucky | 2 88 | 2 89 | 2 83 | 2 87 | 3 94 | 3 14 |
| Montana | 0 | 0 | 0 | 0 | 12 00 | 11 72 |
| New Mexico | 0 | 0 | 6 00 | 5 50 | 5 00 | 5 00 |
| Ohio | 2 54 | 2 49 | 2 57 | 2 57 | 2 49 | 2 78 |
| Pennsylvania | 1 86 | 1 70 | 1 55 | 1 22 | 1 25 | 1 25 |
| Tennessee | 2 42 | 2 33 | 2 52 | 2 25 | 1 95 | 1 31 |
| Utah | 10 00 | 0 | 10 00 | 0 | 0 | 0 |
| Virginia | 0 | 0 | 0 | 1 75 | 1 75 | 1 75 |
| Washington | 0 | 0 | 0 | 0 | 4 75 | 4 75 |
| West Virginia | 2 30 | 2 30 | 2 26 | 2 19 | 1 19 | 1 86 |
| Total average | 1 99 | 1 88 | 1 77 | 1 49 | 1 49 | 1 49 |

As was explained in the report for 1884, the value of coke in certain localities in which but a small amount is produced, and that for local consumption, depends upon the price at which coke from other localities can be laid down. For example, the highest price per ton quoted in the table is $11.72, in Montana, while the lowest price is $1.25, in Pennsylvania. Intrinsically the Pennsylvania coke is superior to the Montana coke, and it is probable that the price of the Montana coke was regulated by the price at which Pennsylvania or Connellsville coke could be sold delivered to the smelters or founders of that Territory. It therefore by no means follows that the rate per ton at which coke sells is an evidence of its value as a fuel.

It is interesting to note that during the past three years there has been no change in the average value of the coke produced in the United States, it being $1.49 for this period. It hardly seems necessary to say that this average is obtained, not by taking the average of the prices given in this table, but by dividing the total value of the coke produced, given in the last preceding table, by the total number of tons of coke. In other words, the $1.49 is a true average price, not an average of prices.

*Amount of coal consumed in the manufacture of coke.*—In the following table is given the total number of tons of coal which entered into the manufacture of coke in the United States for the years from 1880 to 1885. In this statement is included all of the coal charged into the ovens, without any reference to its condition when so charged. A large proportion of the coal used is "run of the mine"; that is, all of the coal as it comes from the pit—lump, nut, and slack—is charged without screen-

ing into the ovens, the coal in these cases being mined only for the purpose of being made into coke. This is especially true of the Connellsville, the Alleghany Mountain, and the Reynoldsville-Walston districts in Pennsylvania, the New River district in West Virginia, and the Warrior district in Alabama, as well as several others. On the other hand, a large amount of coking, as will appear from the statement made in connection with the industry in different districts, is for the purpose of utilizing the slack coal produced in mining. This is true of the Pittsburgh district in Pennsylvania, as well as of many of the localities producing but a small amount of coke. It was not found practicable, however, as suggested above, to distinguish between the coal which was used as "run of the mine" and that which was used as "slack."

*Amount of coal used in the manufacture of coke in the United States from* 1880 *to* 1885, *by States and Territories.*

| States and Territories. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| Alabama | 106,283 | 184,881 | 261,839 | 359,699 | 413,184 | 507,934 |
| Colorado | 51,891 | 97,508 | 180,549 | 224,089 | 181,968 | 208,069 |
| Georgia | 63,402 | 68,960 | 77,670 | 111,687 | 132,113 | 117,781 |
| Illinois | 31,240 | 35,240 | 25,270 | 31,370 | 30,168 | 21,487 |
| Indiana | 0 | 0 | 0 | 0 | 0 | 0 |
| Indian Territory | 2,494 | 2,852 | 3,266 | 4,150 | 3,084 | 5,781 |
| Kansas | 4,800 | 8,800 | 9,200 | 13,400 | 11,500 | 15,000 |
| Kentucky | 7,206 | 7,406 | 6,906 | 8,437 | 3,451 | 5,075 |
| Montana | 0 | 0 | 0 | 0 | 165 | 300 |
| New Mexico | 0 | 0 | 1,500 | 6,941 | 29,990 | 31,889 |
| Ohio | 172,453 | 201,145 | 181,577 | 152,502 | 108,164 | 68,796 |
| Pennsylvania | 4,347,558 | 5,393,503 | 6,149,179 | 6,823,275 | 6,204,604 | 6,178,500 |
| Tennessee | 217,656 | 241,644 | 313,537 | 330,961 | 348,295 | 412,538 |
| Utah | 2,000 | 0 | 500 | 0 | 0 | 0 |
| Virginia | 0 | 0 | 0 | 39,000 | 99,000 | 81,899 |
| Washington | 0 | 0 | 0 | 0 | 700 | 544 |
| West Virginia | 230,758 | 304,823 | 366,653 | 411,159 | 385,588 | 415,533 |
| Wyoming | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 5,237,741 | 6,546,662 | 7,577,646 | 8,516,670 | 7,951,974 | 8,071,126 |

It will be noted that during the past year there has been a small increase in the amount of coal consumed over that used in 1884, the production of coke having increased. The increase in coal consumed, however, is not as great proportionately as the increase in the production of coke, owing to the larger yield of the coal; that is, less coal was required per ton of coke made. The amount of coal necessary in 1885 to produce a ton of coke was 1.58 tons, or 3,160 pounds; in 1884 it was 1.63 tons, or 3,260 pounds.

*Yield of coal in coke.*—The table given below shows the average yield of the coal coked in the United States for the six years covered by this report. By the yield is meant the percentage of the constituents of the coal that remained in the coke after the process of coking.

*Percentage yield of coal in the manufacture of coke in the United States in the years* 1880 *to* 1885, *by States and Territories.*

| States and Territories. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Alabama | 57 | 59 | 58 | 60 | 60 | 59 |
| Colorado | 49 | 50 | 57 | 60 | 64 | 63 |
| Georgia | 60 | 60 | 60 | 60 | 60 | 60 |
| Illinois | 41 | 42 | 45 | 43 | 43 | 48 |
| Indiana | 0 | 0 | 0 | 0 | 0 | 0 |
| Indian Territory | 62 | 62 | 62 | 62 | 62 | 62 |
| Kansas | 64 | 64.4 | 65 | 62.9 | 62¼ | 53⅜ |
| Kentucky | 60 | 60 | 59 | 60 | 64 | 53 |
| Montana | 0 | 0 | 0 | 0 | 46 | 58½ |
| New Mexico | 0 | 0 | 66⅜ | 57¼ | 57½ | 56¼ |
| Ohio | 58 | 59 | 57 | 58 | 58 | 57 |
| Pennsylvania | 65 | 64 | 64 | 65 | 62 | 64.6 |
| Tennessee | 60 | 60 | 60 | 62 | 63 | 53 |
| Utah | 50 | 0 | 50 | 0 | 0 | 0 |
| Virginia | 0 | 0 | 0 | 64½ | 64¼ | 60 |
| Washington | 0 | 0 | 0 | 0 | 57½ | 57 |
| West Virginia | 60 | 61 | 63 | 63 | 62 | 63 |
| Total average | 63 | 63 | 63 | 64 | 61 | 63 |

Some of the percentages in this table are in part estimates. As has been stated, a great deal of the coal coked is slack, and this is frequently charged into the ovens without weighing. In such cases only an estimate of the amount used could be given.

There has been an increase in the average yield of coal in coke in 1885, as compared with 1884, of 2 per cent.; that is, the yield in 1884 was 61 per cent. and in 1885 63 per cent. This is due chiefly to the increased yield reported at the works in Pennsylvania. Attention was called in the last report to the fact that the apparent yield of coal in coke in this State dropped suddenly from 65 per cent. in 1883 to 62 per cent. in 1884. This, it was stated, was manifestly an error. As the yield in each of the years prior to 1884 was not less than 64 per cent., and in one case 65 per cent., it was estimated that the real yield in Pennsylvania in 1884 should be 64 per cent. The figures for 1885 justify this conclusion. It should be said in regard to these figures that they are the results obtained from the reports forwarded, and include the yield in the whole State, not in the best districts only.

*Imports and exports of coke.*—The following table gives the amount of coke imported and entered for consumption in the United States from 1869 to 1885, inclusive. In the statement is included, not only that entered for consumption, but the withdrawals from warehouse for consumption. The years are the Government fiscal years ending June 30. In the reports of the Treasury Department the quantities are long tons. These have been reduced to short tons to make the table commensurate with the other tables in this chapter.

*Coke imported and entered for consumption in the United States, 1869 to 1885, inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Short tons.* | | | *Short tons.* | |
| 1869 | ..... | $2,053 | 1878 | 6,616 | $24,186 |
| 1870 | ..... | 6,388 | 1879 | 6,035 | 24,748 |
| 1871 | ..... | 19,528 | 1880 | 5,047 | 18,406 |
| 1872 | 9,575 | 9,217 | 1881 | 15,210 | 64,987 |
| 1873 | 1,091 | 1,366 | 1882 | 14,924 | 53,244 |
| 1874 | 634 | 4,588 | 1883 | 20,634 | 113,114 |
| 1875 | 1,046 | 9,648 | 1884 | 14,483 | 36,278 |
| 1876 | 2,065 | 8,657 | 1885 | 20,876 | 64,814 |
| 1877 | 4,068 | 16,686 | | | |

The imported coke goes chiefly to the Pacific coast, where it is mainly used in smelting the argentiferous lead ores; and the coke so imported is almost entirely English and Welsh. Some coke from Nova Scotia is also imported into New England.

The exports of coke are insignificant, as will be seen from the following table. What proportion, if any, is of foreign coke re-exported is not known.

*Coke exported from the United States, 1882 to 1885, inclusive.*

| Fiscal years ending June 30. | Value. |
|---|---|
| 1882 | $1,123 |
| 1883 | 3,281 |
| 1884 | 4,042 |
| 1885 | 5,062 |

## ALABAMA.

The healthy and rapid growth of the coke industry in Alabama, noted in the last volume of the "Mineral Resources," continued during the year 1885. At the close of 1884 there were 976 ovens in the State, and 242 more in process of construction. The close of 1885 finds 1,075 ovens built, and 16 in process of construction. While it thus appears that there has been marked progress, it is also true that the depressed condition of the iron trade, in the various processes of which most of the coke produced is consumed, has seriously interfered with the production of coke in Alabama during 1885, and has prevented the building of ovens and works that were in contemplation at the close of 1884. Notwithstanding this, however, it will be noted that there has been a considerable increase in the number of ovens and in the production of coke.

As noted above, the total number of ovens built up to December 31, 1885, was 1,075. Of these 914 were in the Warrior coal field; 100, with some pits, in the Cahaba field; and 61 in the Coosa or Broken Arrow region. The ovens at one of the works in the Warrior field were started at the close of the year. There are 6 ovens in process of construction in the Warrior field, and 10 in the Coosa.

The total production of coke in Alabama during the year 1885 was 301,180 short tons, of which 279,830 tons were produced at the 7 establishments in the Warrior field. There were used in the production of this coke 507,934 tons of coal, the yield of the coal in coke at the various establishments ranging from 50 to 66 per cent., the average being 59 per cent. The total value of this coke was $755,645, the range in value per ton being from $2.48 to $3 at the ovens, the most common price being $2.50 and the average but a fraction over $2.50.

The following are the statistics of the manufacture of coke in Alabama from 1880 to 1885:

*Statistics of the manufacture of coke in Alabama, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 4 | 4 | 5 | 6 | 8 | 11 |
| Ovens built | 316 | 416 | 536 | 767 | (a) 976 | (a) 1,075 |
| Ovens building | 100 | 120 | ..... | 122 | 242 | 16 |
| Coal used, short tons | 106,283 | 184,881 | 261,839 | 359,699 | 413,184 | 507,934 |
| Coke produced, short tons | 60,781 | 109,033 | 152,940 | 217,531 | 244,009 | 301,180 |
| Total value of coke at ovens | $183,063 | $326,819 | $425,940 | $598,473 | $609,185 | $755,645 |
| Value of coke at ovens, per ton | $3.01 | $3.00 | $2.79 | $2.75 | $2.50 | $2.50 |
| Yield of coal in coke, per cent | 57 | 59 | 58 | 60 | 60 | 59 |

*a* One establishment made coke on the ground.

The coke from the Warrior field, chiefly from the Pratt vein, still holds its pre-eminence among Alabama cokes, 93 per cent. of the coke made in the State being from the coals of this field. The principal use of this coke is in the blast furnaces near Birmingham, but it goes to all of the large cities of the South and Southwest for manufacturing purposes. Some brands, the Black Creek coke especially, have an excellent reputation for foundry use. This Black Creek coke is also used, when properly prepared, for domestic consumption.

At the close of 1884 but five coke works were in operation in the Warrior field. A sixth was started early in the following year, and a seventh—that of the Warrior Coal and Coke company, at Warrior—fired its ovens late in December, making the first shipment of foundry coke December 31. The following are analyses of the coal and coke from the mines and ovens of this company:

*Analyses of Warrior coal and coke.*

| Coal. | Per cent. | Coke. | Per cent. |
|---|---|---|---|
| Fixed carbon | 65.12 | Carbon | 93.86 |
| Volatile matter | 32.24 | Moisture | 2.55 |
| Ash | 1.27 | Ash | 2.98 |
| Sulphur | .56 | Sulphur | .61 |
| Total | 99.19 | Total | 100.00 |

In the Cahaba field but little coke was made in 1885. The ovens of the Pratt Coal and Iron company, at Helena, were in blast but a short

time. The Cahaba Coal Mining company also made some coke in pits on the ground. The coke from this field is too high in ash for iron making. It is also an inferior fuel in other respects.

In 1884 the only coke made in the Coosa field was in an experimental way. At the close of 1885, however, 61 ovens were in operation in the Broken Arrow district, and 10 Thomas ovens, 7 feet by 36 inches, were in course of construction. The coke from this district is used in the Cherokee furnace at Cedartown, Georgia, a charcoal furnace which at times uses coke.

The Broken Arrow vein, in the Coosa field, is from 38 inches to 43 inches thick; the Browning, 32 to 38 inches. All of the coal in the Coosa field must be washed before coking. The Broken Arrow coal is only used for coking, its coking or caking qualities being so good as to preclude its use for steam purposes. It is low in sulphur (0.65 per cent.), but carries considerable ash, part of which can be removed by washing, for which purpose a washer is being erected, no coke being made at present at the Broken Arrow works.

Only the slack from the Browning coal is used in coking. It carries considerable sulphur in the form of pyrites, which washing removes to a large extent. A "plunger and trough" washer, Thomas system, with a crusher, has been erected, and the coke much improved. Water pumped from the mine is used for washing. A late analysis shows: ash, 8.35 per cent.; sulphur, 0.78 per cent. The physical tests by Mr. John Fulton, of Johnstown, Pennsylvania, give about the same results as Connellsville coke. This coke is used at the Cherokee furnace, making No. 1 foundry iron. There are three other charcoal furnaces contiguous to this district that contemplate using coke. Some 300 tons of coal are raised daily at this mine, the slack from which (50 per cent. of total) is washed and coked. Forty cents a ton is paid for mining. The total cost of coal in cars is 68 cents. The coal from the Browning vein was used during the late war by the Confederate government in their foundry at Selma, Alabama. The coal was run in on a tram-car to the Coosa river and floated down to Selma. It was also made into coke on the ground at the mines. Pieces made at that time are still found, as bright, apparently, as ever.

### COLORADO.

Coking coal occurs in three localities or districts in the Colorado coal field, which may be termed the El Moro, the Crested Butte, and the Durango. The first district includes the ovens at El Moro and Starkville; the second, those at Crested Butte and at Aspen; and the third, those at Durango and Rico.

The most important of these districts is the first, the El Moro, situated in Las Animas county, near the boundary line of New Mexico. This, as well as the Crested Butte district, was quite fully described in the "Mineral Resources" for 1883 and 1884. There has been no increase

in the number of ovens in the district during the year. The production for 1885 shows a slight falling off from that of 1884. No statement as to the value of coke made in this district was given. Its value has been estimated, in the absence of this statement, at $3 a ton.

In the Crested Butte district there are two works, the Crested Butte, with 74 ovens, an increase during the year of 24, and the Jerome Park, with 5 ovens. The latter works also made some coke on the ground. The Crested Butte works were described in the last report. The Jerome Park Coal company's ovens are at Garfield, on Edgeton creek, about 40 miles north of Aspen. The vein of coal at this point is 5½ feet thick and cokes well. An analysis of the coal is as follows:

*Analysis of Jerome Park Coal company's coal.*

| | Per cent. |
|---|---|
| Carbon | 57.0 |
| Volatile matter | 37.9 |
| Water | 2.5 |
| Ash | 2.6 |
| | 100.0 |

The coke is used in smelting at Aspen, by the Aspen Mining and Smelting company.

In the Durango field there are three small coke works, making coke for use locally in smelting ores. The largest works has but 8 ovens, one of the others, 6; and the smallest, 4. Most of the coke in this district is high in ash, but the transportation charges on the cokes of other sections are so heavy as to make it more profitable to use these local cokes, though they are inferior fuels.

As will be seen from the following table, there were seven coke works in Colorado at the close of 1885, a loss of one during the year. There were 434 ovens, an increase of 24, which were building at the beginning of the year. The make of coke in 1885 was 131,960 tons, an increase of 16,241 tons. Its value in 1885 was $512,162, or $3.88 per ton, as against $409,930, or $3.45 a ton in 1884.

The statistics of the manufacture of coke in Colorado for the years from 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in Colorado, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 1 | 2 | 5 | 7 | 8 | 7 |
| Ovens built | 200 | 267 | 344 | 352 | 409 | 434 |
| Ovens building | 50 | 0 | 0 | 0 | 24 | 0 |
| Coal used, short tons | 51,891 | 97,508 | 180,549 | 224,089 | 181,968 | 208,069 |
| Coke produced, short tons | 25,568 | 48,587 | 102,105 | 133,997 | 115,719 | 131,960 |
| Total value of coke at ovens | $145,226 | $267,156 | $476,665 | $584,578 | $409,930 | $512,162 |
| Value of coke at ovens, per ton | $5.68 | $5.29 | $4.67 | $4.36 | $3.45 | $3.88 |
| Yield of coal in coke, per cent | 49 | 50 | 57 | 60 | 64 | 63 |

Some of the coke produced in 1883 and 1885 was made in heaps on the ground.

## GEORGIA.

Though all of the coke ovens in this State are owned by one company, and are usually reported as but one works, there are really two distinct works, one with 286 ovens, and the other with 14 ovens, some two miles distant. This latter bank of ovens has not been in operation during the past year. The coke reported, therefore, was made at the works with 286 ovens. But little of the coke made is sold, the company using most of it at its two furnaces, the Rising Fawn and Chattanooga.

The statistics of the manufacture of coke in this State for the years 1880–1885, inclusive, are as follows:

*Statistics of the manufacture of coke in Georgia, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 1 | 1 | 1 | 1 | 1 | 2 |
| Ovens built | 140 | 180 | 220 | 264 | 300 | 300 |
| Ovens building | 40 | 40 | 44 | 36 | 0 | 0 |
| Coal used, short tons | 63,402 | 68,960 | 77,670 | 111,687 | 132,113 | 117,781 |
| Coke produced, short tons | 38,041 | 41,376 | 46,602 | 67,012 | 79,268 | 70,669 |
| Total value of coke at ovens | $81,789 | $88,753 | $100,194 | $147,166 | $169,192 | $144,198 |
| Value of coke at ovens, per ton | $2.15 | $2.15 | $2.15 | $2.20 | $2.13 | $2.04 |
| Yield of coal in coke, per cent | 60 | 60 | 60 | 60 | 60 | 60 |

## ILLINOIS.

The year 1885 was by no means a successful one to the Illinois coke manufacturer. The number of coke works in this State was the same at the close of 1885 as at the close of 1884, but the number of ovens had fallen off five, and the production of coke from 13,095 tons in 1884, to 10,350 tons in 1885. The total value of the coke produced in 1885, however, was greater than in 1884.

The causes of the failure of the attempts at coke making in this State, notwithstanding the extensive deposits of coal which it possesses, have been pointed out in previous reports. They are: an inferior coal, and the relations of the markets in which the coke must be sold to other sources of supply. The coke is as a rule quite impure, though at one of the works a good coke in this respect is made, and the coal is not the best as to coking qualities. The demand for it depends upon the price of the better cokes of the Connellsville and West Virginia regions. With the prices of the past year, but little Illinois coke could be sold at rates that would pay the cost of manufacture and transportation. As a result, of the 9 works reported as in existence, 5, embracing 175 ovens, were idle during the entire year; one of the others ran but a few weeks. At another, with only 100 ovens, only 18 were run regularly, and operations at the other works were not continuous.

The coking of the Streator coal, noticed last year, has been continued, the coke being used at the wire mills at Joliet, and at the Streator glass

works. It is stated to be an excellent soft coke, but here, as in the other sections of the State, the cheapness of the Connellsville and other Pennsylvania cokes has reduced demand, as well as prevented a contemplated enlargement of the works.

The following are the statistics of the manufacture of coke in Illinois for the years from 1880 to 1885:

*Statistics of the manufacture of coke in Illinois, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 6 | 6 | 7 | 7 | 9 | 9 |
| Ovens built | 176 | 176 | 304 | 316 | 325 | 320 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 31,240 | 35,240 | 25,270 | 31,170 | 30,168 | 21,487 |
| Coke produced, short tons | 12,700 | 14,800 | 11,400 | 13,400 | 13,095 | 10,350 |
| Total value of coke at ovens | $41,950 | $45,850 | $29,050 | $28,200 | $25,639 | $27,798 |
| Value of coke at ovens, per ton | $3.30 | $3.10 | $2.55 | $2.10 | $1.96 | $2.68 |
| Yield of coal in coke, per cent | 41 | 42 | 45 | 43 | 43 | 48 |

The range of prices at the several works reported was from $2 a ton to $3.78; the average, as given, $2.68. The yield of coal in coke was from 45 to 50 per cent., with an average of 48 per cent.

## INDIANA.

No coke has been made in Indiana since 1879. There are, however, nominally two coke works in the State, with 12 ovens at one works in a condition to resume operations with slight repairs, should it ever be deemed advisable. At the other, where there are 25 ovens, work has been abandoned. As the ovens are still in existence, however, they are still reported, giving a total in the State of 37 ovens.

## INDIAN TERRITORY.

The number of ovens at the only works in this Territory has been doubled during the year, there being 40 at the close of 1885 as against 20 at the close of 1884. There has been a considerable increase in the production of coke during 1885, the make being 3,584 tons as compared with 1,912 tons in 1884. Only slack is used. The following analysis of the coke by Regis Chauvenet & Bro., differs somewhat from that given in the last report:

*Analysis of coke from McAlister, Indian Territory.*

| | *Per cent.* |
|---|---|
| Fixed carbon | 87.02 |
| Volatile matter | 2.45 |
| Moisture | 0.21 |
| Ash | 10.32 |
| | 100.00 |
| Sulphur | 1.22 |
| Phosphorus | 0.03 |

The statistics of the manufacture of coke in the Territory for the years 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in Indian Territory, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 1 | 1 | 1 | 1 | 1 | 1 |
| Ovens built | 20 | 20 | 20 | 20 | 20 | 40 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 2,494 | 2,852 | 3,266 | 4,150 | 3,084 | 5,781 |
| Coke produced, short tons | 1,546 | 1,768 | 2,025 | 2,573 | 1,912 | 3,584 |
| Total value of coke at ovens | $4,638 | $5,304 | $6,075 | $7,719 | $5,736 | $12,902 |
| Value of coke at ovens, per ton | $3 | $3 | $3 | $3 | $3 | $360 |
| Yield of coal in coke, per cent | 62 | 62 | 62 | 62 | 62 | 62 |

In the returns received no statement as to coal used was included. A yield of 62 per cent. has been assumed.

## KANSAS.

But little coke is made in Kansas, and that chiefly to utilize the slack coal from the mines in the southeastern part of the State. The works are small, and the coke produced, with the exception of that from one bank of ovens, is made by zinc smelters for use in their own furnaces. The coke from the only establishment not so operated is used for domestic purposes and for drying brick. The coke is only fair, containing considerable ash, and at times as much as 4 per cent. of sulphur, which, of course, unfits it for foundry use.

There has been no change in the number of works or ovens during 1885. There has been a slight increase over 1884 in the amount of coke made, but a decrease in its value. At one of the four works, with three ovens, no coke was made during the year.

The statistics of the manufacture of coke from 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in Kansas, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 2 | 3 | 3 | 4 | 4 | 4 |
| Ovens built | 6 | 15 | 20 | 23 | 23 | 23 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 4,800 | 8,800 | 9,200 | 13,409 | 11,500 | 15,000 |
| Coke produced, short tons | 3,070 | 5,670 | 6,080 | 8,430 | 7,190 | 8,050 |
| Total value of coke at ovens | $6,000 | $10,200 | $11,460 | $16,560 | $14,580 | $13,255 |
| Value of coke at ovens per ton | $1.95 | $1.80 | $1.70 | $1.96 | $2.02 | $1.65 |
| Yield of coal in coke, per cent | 64 | 64.4 | 65 | 62.9 | 62.5 | 53⅔ |

Some of the coke reported made in 1880 and 1881 was produced at one establishment in pits.

## KENTUCKY

Though Kentucky possesses extensive beds of coal, some of which are coking, it can hardly be said to produce coke. So far as reported, all of the coke made in this State in 1885 was from slack coal from other States. No coke has been made in the western field, and as far as has

been learned the good coking coals said to exist in the eastern part of the State have not been utilized. In this eastern field has been found what is supposed to be the identical horizon of the Connellsville district. This Kentucky field Mr. Procter, the State geologist, has called the "Elkhorn" coking coal, from the name of the creek on which it was first discovered. The coal is found in veins from 7 to 11 feet thick.

The number of works is the same as at the close of 1884. Of these two were idle the entire year. The number of ovens has decreased by twelve. There has been a slight increase in the amount of coke made, but a decrease in the value.

The following are the statistics of the manufacture of coke in Kentucky for the years from 1880 to 1885. As no coke was made in the western district in 1885, but one table is made. In this district there are two works with nine ovens:

*Statistics of the total manufacture of coke in Kentucky,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 5 | 5 | 5 | 5 | 5 | 5 |
| Ovens built | 45 | 45 | 45 | 45 | 45 | 33 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 7,206 | 7,406 | 6,906 | 8,437 | 3,451 | 5,075 |
| Coke produced, short tons | 4,250 | 4,370 | 4,070 | 5,025 | 2,223 | 2,704 |
| Total value of coke at ovens | $12,250 | $12,630 | $11,530 | $14,425 | $8,760 | $8,499 |
| Value of coke at ovens per ton | $2.88 | $2.89 | $2.83 | $2.87 | $3.94 | $3.14 |
| Yield of coal in coke, per cent | 60 | 60 | 59 | 60 | 64 | 53 |

## MONTANA.

But little information relative to the coke made in this Territory, other than that contained in the last report, has been received. All of the works may be regarded as purely experimental, and though there are constant rumors of enterprises of considerable magnitude being in contemplation or in progress, the close of 1885 finds fewer ovens than in 1884. One report from this Territory says that the coke made thus far "has simply been experimental, and results have not warranted the erection of a larger plant." The firm of Quealy & Hoffman, the largest producers in 1884, made coke for a little while in 1885 and then abandoned its manufacture entirely. At the Northern Pacific Coal Company's works experiments in washing the coal are in progress. The results justify the belief that the high percentage of ash, which the unwashed coal carries, can be so reduced as to justify coke manufacture on a larger scale.

At Anaconda some little coke has been made as an experiment. The coal requires washing, but the coke made is reported to be bright, silvery, of a somewhat open structure, and carrying small bits of slate.

It is reported that recent tests have proved that the Sand Coulee coal makes good coke. Experiments with coal from Arnold & Potts's mine, near Maiden, are also reported as giving satisfactory results. Of the details of these tests no statement has been received.

The statistics of the manufacture of coke in Montana from 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in Montana, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 0 | 0 | 0 | 1 | 3 | 2 |
| Ovens built | 0 | 0 | 0 | 2 | 5 | 2 |
| Ovens building | 0 | 0 | 0 | 0 | 12 | 0 |
| Coal used, short tons | 0 | 0 | 0 | 0 | 165 | 300 |
| Coke produced, short tons | 0 | 0 | 0 | 0 | 75 | 175 |
| Total value of coke at ovens | 0 | 0 | 0 | 0 | $900 | $2,063 |
| Value of coke at ovens, per ton | 0 | 0 | 0 | 0 | $12 | $11.72 |
| Yield of coal in coke, per cent | 0 | 0 | 0 | 0 | 46 | 58.5 |

## NEW MEXICO.

No ovens were built in New Mexico during the year 1885. The San Pedro Coal and Coke Company, at San Antonio, on the Rio Grande, remains the only works with ovens in the Territory. This is also the only works at which, so far as could be learned, any coke was made in 1885, none being produced in the Cerrillos mining district.

The following are the statistics of the manufacture of coke in New Mexico from 1880 to 1885. The value of the coke is an estimate:

*Statistics of the manufacture of coke in New Mexico, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 0 | 0 | 2 | 2 | 2 | 2 |
| Ovens built (*a*) | 0 | 0 | 0 | 12 | 70 | 70 |
| Ovens building | 0 | 0 | 12 | 28 | 0 | 0 |
| Coal used, short tons | 0 | 0 | 1,500 | 6,941 | 29,990 | 31,889 |
| Coke produced, short tons | 0 | 0 | 1,000 | 3,905 | 18,282 | 17,940 |
| Total value of coke at ovens | 0 | 0 | $6,000 | $21,478 | $91,410 | $89,700 |
| Value of coke at ovens per ton | 0 | 0 | $6 | $5.50 | $5 | $5 |
| Yield of coal in coke, per cent | 0 | 0 | 66⅔ | 57¼ | 57¼ | 56¼ |

*a* At one works there are ten stone pits, with an average capacity of 10 tons each.

## OHIO.

The statistics of the manufacture of coke in Ohio in 1885 show a marked decline in this industry as compared with 1884. While most of the coal of the State is classed as coking coal, but little of it makes as good a coke as the Connellsville or New River. Some of the cokes of Ohio are lower in ash than that made in Pennsylvania, but, as has been stated elsewhere, relative purity is not always an indication of the economic value of a coke. The Ohio cokes are usually soft, brittle, high in sulphur, and in many cases in ash also, though this is not always true. The Steubenville coke is low in ash, but is a very weak coke, breaking easily and not bearing transportation, a large part of it becoming dust even in transporting it but a few hundred yards from the ovens to the blast furnace. The Washingtonville coke, made at

Leetonia, is also a pure coke, not as compact as Connellsville, will not stand transportation as well, but is regarded as better than Connellsville in smelting the native ores, and is equal to it in carrying burden. It will be found that when Connellsville coke can be placed at blast furnaces at the prices ruling the past year but little blast furnace coke will be made in this State.

In the last report four coking districts were named: Washingtonville, Steubenville, Hocking Valley, and Cincinnati. Some coke was also formerly made near Zanesville, where there are four ovens, and some in the Hanging Rock region, but none has recently been produced in either of these localities.

*Washingtonville district.*—The following are the statistics of the manufacture of coke in this district, which includes the ovens near Leetonia, for the years 1880 to 1885:

*Statistics of the manufacture of coke in the Washingtonville district, Ohio,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 3 | 3 | 3 | 3 | 3 | 2 |
| Ovens built | 204 | 204 | 204 | 204 | 204 | 267 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 76,321 | 66,972 | 67,516 | 57,785 | 53,363 | 43,387 |
| Coke produced, short tons | 43,433 | 39,718 | 36,646 | 31,304 | 29,933 | 24,089 |
| Total value of coke at ovens | $128,608 | $119,383 | $110,617 | $87,651 | $63,806 | $66,245 |
| Value of coke at ovens per ton | $2.96 | $3.01 | $3.01 | $2.80 | $2.90 | $2.75 |
| Yield of coal in coke, per cent | 57 | 59 | 54 | 54 | 57 | 55 |

At one works in this district, with ten ovens, coke making has been abandoned. A second works, with fifty ovens, has been idle the entire year, so that all the coke was made at one establishment.

*Steubenville district.*—In this district are included the ovens in the vicinity of Steubenville, as well as those near Bellaire.

The following are the statistics of the manufacture of coke in this district from 1880 to 1885:

*Statistics of the manufacture of coke in the Steubenville district, Ohio,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 7 | 7 | 8 | 9 | 10 | 5 |
| Ovens built | 360 | 385 | 391 | 401 | 451 | 273 |
| Ovens building | 25 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 77,486 | 111,561 | 92,199 | 57,961 | 21,217 | 7,929 |
| Coke produced, short tons | 45,835 | 65,752 | 54,161 | 35,313 | 13,356 | 4,365 |
| Total value of coke at ovens | $83,789 | $122,953 | $106,971 | $70,631 | $25,691 | $7,605 |
| Value of coke at ovens per ton | $1.83 | $1.87 | $1.98 | $2 | $1.92 | $1.74 |
| Yield of coal in coke, per cent | 59 | 59 | 59 | 61 | 63 | 55 |

It will be seen from the table that there has been a most decided falling off in the coke industry in this locality during the past year. Five works, with one hundred and seventy-eight ovens, have gone out of ex-

istence, and only about one-third as much coke has been made in 1885 as in 1884. Indeed, the present insignificance of this district as compared with former years, with 1881, for example, when 65,753 tons were made, is evident. The blast furnaces of this section are too near Connellsville.

All of the coke made was from three works, both of the banks of ovens connected with blast furnaces being idle the entire year. All of the coke was made from slack coal.

*Hocking Valley district.*—No coke was made in this district in 1885. As was stated in the last report, the coke made at Happy Hollow, the only locality at which there are ovens, while fairly firm, was too high in sulphur for smelting purposes. Experiments demonstrated that this sulphur could be removed with proper machinery, and until this is erected it is not probable that any more coke will be made at these works. As it is the intention to erect this, however, the report is carried along.

*Statistics of the manufacture of coke in the Hocking valley, Ohio,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 1 | 1 | 1 | 1 | 1 | 1 |
| Ovens built | 20 | 20 | 20 | 20 | 20 | 20 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 2,505 | 1,905 | 2,175 | 2,778 | 1,450 | 0 |
| Coke produced, short tons | 1,002 | 762 | 870 | 1,111 | 580 | 0 |
| Total value of coke at ovens | $1,253 | $953 | $1,088 | $1,388 | $725 | 0 |
| Value of coke at ovens per ton | $1.25 | $1.25 | $1.25 | $1.25 | $1.25 | 0 |
| Yield of coal in coke, per cent | 40 | 40 | 40 | 40 | 40 | 0 |

*Cincinnati district.*—All the coke made in Cincinnati is from the screenings and small coal of the coal yards and boats. Most of the coal coming to Cincinnati is brought by the Ohio river in boats and barges, from which it is elevated into the numerous coal yards of the city. Large amounts of fine and small coal result from the weathering and hauling, and this is coked. Though made in Ohio, therefore, but little of the coal used is from this State. The following are the statistics of the manufacture of coke in this district from 1880 to 1885:

*Statistics of the manufacture of coke in the Cincinnati district, Ohio,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 4 | 4 | 4 | 5 | 5 | 5 |
| Ovens built | 32 | 32 | 32 | 57 | 57 | 82 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 16,141 | 20,607 | 19,687 | 33,978 | 32,134 | 17,489 |
| Coke produced, short tons | 10,326 | 13,237 | 12,545 | 20,106 | 18,840 | 10,962 |
| Total value of coke at ovens | $42,255 | $54,439 | $47,437 | $65,990 | $61,072 | $35,873 |
| Value of coke at ovens per ton | $4.09 | $4.11 | $3.78 | $3.28 | $3.24 | $3.27 |
| Yield of coal in coke, per cent | 64 | 64 | 64 | 59 | 59 | 63 |

*Total production in Ohio.*—In the following table the statistics of coke making in the several districts of Ohio for the years 1880 to 1885 are consolidated:

*Statistics of the manufacture of coke in Ohio, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 15 | 15 | 16 | 18 | 19 | 13 |
| Ovens built | 616 | 641 | 647 | 682 | 732 | 642 |
| Ovens building | 25 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 172,453 | 201,045 | 181,577 | 152,502 | 108,164 | 68,796 |
| Coke produced, short tons | 100,596 | 119,469 | 103,722 | 87,834 | 62,709 | 39,416 |
| Total value of coke at ovens | $255,905 | $297,728 | $266,113 | $225,660 | $156,294 | $109,723 |
| Value of coke at ovens per ton | $2.54 | $2.49 | $2.57 | $2.57 | $2.49 | $2.78 |
| Yield of coal in coke, per cent | 58 | 59 | 57 | 58 | 58 | 57 |

## PENNSYLVANIA.

For convenience of reference the coke ovens of Pennsylvania have been arranged in ten districts, as follows:

1. Connellsville.
2. Irwin-Latrobe (Pennsylvania railroad).
3. Alleghany Mountain and Somerset.
4. Snow Shoe.
5. Broad Top.
6. Pittsburgh.
7. Beaver.
8. Alleghany Valley.
9. Reynoldsville-Walston.
10. Blossburg.

These divisions are, in part, based upon geological and topographical distinctions, and in part upon the routes to market of the coke produced. Each district will be discussed and its statistics given separately.

In all of the six principal basins, into which the coal fields of western Pennsylvania were divided by Professor Rogers, coke was made in 1885. The bulk of the product, however, was from the Connellsville and its northwardly extension, the Irwin-Latrobe. Most of the coke was made from the coal of the great Pittsburgh seam, which is, on the whole, the most extensive and important coal bed in the Appalachian basin. It is the main seam worked at Pittsburgh, on the Monongahela and Youghiogheny rivers, at Connellsville, Wheeling, and many other places, and is estimated to underlie, in the States of Pennsylvania, Ohio, and West Virginia, 14,000 square miles. In southwestern Pennsylvania Professor Lesley estimates that this bed, after all the erosion it has undergone, is found over an area of somewhat less than 3,000 square miles, so situated that every square yard of it can be reached. This bed does not everywhere show the same thickness as in western Pennsylvania, where it is generally about 8 feet, gradually increasing eastwardly to the Cumberland (Maryland) region, where it is 14 feet; nor does it always make as good coke as that of the Connellsville region, where it is seen at its best.

*Total coke production in Pennsylvania.*—Consolidating the statistics of the different districts of Pennsylvania given below, the following are the statistics of the production of coke in Pennsylvania from 1880 to 1885:

*Statistics of the manufacture of coke in Pennsylvania,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 124 | 132 | 137 | 140 | 145 | 133 |
| Ovens built | 2,501 | 10,881 | 12,424 | 13,610 | 14,285 | 14,553 |
| Ovens building | 836 | 761 | 642 | 211 | 232 | 317 |
| Coal used, short tons | 4,347,558 | 5,393,503 | 6,149,179 | 6,823,275 | 6,204,604 | 6,178,500 |
| Coke produced, short tons | 2,821,384 | 3,437,708 | 3,945,034 | 4,438,464 | 3,822,128 | 3,991,805 |
| Total value of coke at ovens | $5,255,042 | $5,894,579 | $6,133,698 | $5,410,387 | $4,783,230 | $4,981,656 |
| Value of coke at ovens per ton | $1.86 | $1.70 | $1.55 | $1.22 | $1.25 | $1.25 |
| Yield of coal in coke, per cent | 65 | 64 | 64 | 65 | 62 | 64.6 |

*The Connellsville district.*—The Connellsville region or basin, the great coke-producing center of the country, is situated in the southwestern part of Pennsylvania, in the counties of Westmoreland and Fayette, some 50 or 60 miles from Pittsburgh. It is a slender prong separated from the Upper Coal Measures, and may be regarded as extending from near Latrobe, on the Pennsylvania railroad, in a southwesterly direction to the Virginia line, forming a basin some 3 miles wide and 50 long, almost without a fault, the beds yielding from 8 to 10 feet of workable coal. The same trough that contains the Connellsville coal extends northwesterly from Latrobe through the remainder of Westmoreland county, and through Indiana and Clearfield counties, but the Connellsville region is regarded as extending no farther north than the vicinity of Latrobe.

In this district 3,096,012 tons of the 5,106,696 tons, or 60½ per cent., of the coke produced in the United States in 1885 were made. This coke is the typical coke of the country, silvery, cellular, with a metallic ring, tenacious, comparatively free from impurities, and capable of bearing a heavy burden in the furnace. Its porosity and ability to "stand up" in the furnace are what have given it such a reputation as a blast-furnace fuel, and have created such a demand for it for mixing with anthracite and bituminous coal in the East and West, especially where an open iron, such as is used in the Bessemer process, is needed. This region and its coal and coke have been described so fully in the last report as to render any further statement unnecessary.

The following are the statistics of the manufacture of coke in the Connellsville region proper from 1880 to 1885:

*Statistics of the manufacture of coke in the Connellsville region, Pennsylvania,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 67 | 70 | 72 | 74 | 76 | 68 |
| Ovens built | 7,211 | 8,208 | 9,283 | 10,176 | 10,543 | 10,471 |
| Ovens building | 731 | 654 | 592 | 101 | 200 | 48 |
| Coal used, short tons | 3,367,856 | 4,018,782 | 4,628,736 | 5,355,380 | 4,829,054 | 4,683,831 |
| Coke produced, short tons | 2,205,946 | 2,639,002 | 3,043,394 | 3,552,402 | 3,192,105 | 3,096,012 |
| Total value of coke at ovens | $3,948,643 | $4,301,573 | $4,473,789 | $4,049,738 | $3,607,078 | $3,776,388 |
| Value of coke at ovens per ton | $1.79 | $1.63 | $1.47 | $1.14 | $1.13 | $1.22 |
| Yield of coal in coke, per cent | 65½ | 65⅝ | 65¾ | 66⅓ | 66.1 | 66.1 |

There is an apparent reduction in the number of works at the close of 1885 as compared with 1884, but this is due to a consolidation of works rather than to any actual reduction. The number of ovens usually given as in existence in this region is 10,832. The returns show but 10,471. In view of the number of ovens in this region, this difference is not remarkable. Some of these three hundred and sixty-one ovens are old and dilapidated and are not regarded as ovens. It is also a fact, frequently noted by gatherers of statistics, that two reports of the same works, given by the same person but a few days apart, will show differences.

As compared with 1884 the returns show a slight falling off in production. This has been due to the operations of the Pittsburgh syndicate, an organization of the four largest coke producers, who have associated themselves together for the purpose of controlling the production and price of coke. These four firms, at the close of the year, owned 6,453 ovens and controlled the production directly of 1,206 more, and indirectly of all but a small percentage of the balance which sold coke in the open market. Most of the production, outside of that controlled by the syndicate, was by blast furnace proprietors for their own use.

As the demand seemed to require it, the syndicate would order a reduction or increase of production.

*Restrictions during the year, and days worked in each month.*

| Months. | Total days worked. | Restrictions. | | |
|---|---|---|---|---|
| | | Percentage of ovens idle. | Total shut down. | Total days idle. |
| January | 21 | 58 per cent. | 4 Wednesdays, 2 Thursdays | 6 |
| February | 23 | 9th, 50 per cent.; 18th, 40 per cent.; 26th, 20 per cent. | 1 Wednesday | 1 |
| March | 24 | 30 per cent. | 1 Wednesday | 1 |
| April | 19 | 30 per cent. | 5 Wednesdays, 2 Saturdays | 7 |
| May | 20 | 30 per cent.; 10th, 40 per cent. | 2 Saturdays, 4 Wednesdays | 6 |
| June | 22 | 40 per cent. | 3 Wednesdays, 1 Thursday | 4 |
| July | 21 | 40 per cent.; 30th, 50 per cent. | 4 Wednesdays, 2 Saturdays | 6 |
| August | 19 | 50 per cent. | 3 Saturdays, 4 Wednesdays | 7 |
| September | 21 | 50 per cent. | 5 Wednesdays | 5 |
| October | 23 | 50 per cent.; 13th, 47 per cent.; 28th, 40 per cent. | 2 Wednesdays, 2 Thursdays | 4 |
| November | 22 | 40 per cent.; 7th, 35 per cent.; 9th, 30 per cent.; 18th, 20 per cent. | 2 Thursdays, 2 Wednesdays | 4 |
| December | 26 | 20 per cent.; 8th, 10 per cent.; 29th, 5 per cent. | 1 Friday | 1 |
| Total | 261 | | | 52 |

This table needs but little explanation. The column of "total days worked" gives the number of days the ovens were run during each month; the columns "total shut down" the number of days the ovens were idle. These two totals, with the fifty-two Sundays when the ovens were not drawn, makes the three hundred and sixty-five days in the year. The percentage given under the head of "restrictions" gives the percentage of restriction during the days the ovens were run. For ex-

ample: In January the ovens were idle six days out of the twenty-seven working days, and for twenty-one days there was a restriction of 58 per cent. This 58 per cent. restriction continued until the 9th of February, when it was reduced to 50 per cent.; still further reduced on the 18th to 40 per cent., and on the 26th to 30 per cent., where it remained until the 10th day of May, when it was increased to 40 per cent. The subsequent changes are noted in the table. The year closed with a restriction of only 5 per cent.

During most of the year coke has sold, free on board, on the cars at the oven for $1.20 for blast-furnace coke and $1.40 for foundry. The producers, not members of the syndicate, but whose product is controlled and sold by the syndicate, pay it 9 cents a ton for selling, so that it nets but $1.11 to these works, free on board. The average price to the consumer, free on board, at ovens during the year was a small fraction over $1.22. During the past five years the prices, by months, of blast-furnace coke, free on board, at ovens have been as follows:

*Monthly prices of Connellsville blast-furnace coke, free on board, at ovens.*

| Months. | 1881. | | 1882. | | 1883. | | 1884. | 1885. |
|---|---|---|---|---|---|---|---|---|
| January | $1.50 to | $1.75 | $1.70 to | $1.80 | $1.15 to | $1.20 | $1.00 | $1.10 |
| February | 1.50 | 1.75 | 1.70 | 1.80 | 1.20 | 1.10 | 1.00 | 1.10 |
| March | 1.50 | 1.75 | 1.70 | 1.75 | | 1.05 | 1.00 | 1.10 |
| April | 1.60 | 1.75 | 1.70 | 1.75 | | 1.05 | 1.10 | 1.20 |
| May | 1.60 | 1.65 | 1.65 | 1.70 | 0.95 | 1.05 | 1.10 | 1.20 |
| June | 1.60 | 1.65 | 1.50 | 1.65 | | 0.90 | 1.10 | 1.20 |
| July | 1.50 | 1.60 | 1.35 | 1.50 | | 0.90 | 1.10 | 1.20 |
| August | | 1.60 | | 1.35 | | 0.90 | 1.10 | 1.20 |
| September | | 1.60 | 1.25 | 1.35 | | 1.00 | 1.10 | 1.20 |
| October | 1.60 | 1.65 | | 1.25 | | 1.00 | 1.10 | 1.20 |
| November | 1.60 | 1.65 | 1.25 | 1.35 | | 1.00 | 1.10 | 1.20 |
| December | 1.60 | 1.70 | 1.15 | 1.35 | | 1.00 | 1.10 | 1.20 |

It will be noted that the yield of coal in coke is placed at the same figures as last year, 66.1 per cent. There has been considerable discussion over this question of yield. At some important establishments, where the coal is weighed as it is charged, the yield is claimed to be in excess of this. A recent analysis of a coal used at a large number of ovens gave the following:

*Analysis of Connellsville coal.*

| | Per cent. |
|---|---|
| Fixed carbon | 60.30 |
| Volatile matter | 31.38 |
| Ash | 7.24 |
| Phosphorus | .01 |
| Sulphur | 1.09 |
| Total | 100.02 |

The object in burning coke is to drive off the volatile matter; a small amount of the sulphur will also be volatilized, the ash and phosphorus remaining as in the coal. Assuming all the volatile matter is driven

off and the sulphur is reduced to 0.69 per cent., and that no carbon is lost, the coal will yield as follows in coke:

*Theoretical yield of Connellsville coke.*

| | Per cent. |
|---|---|
| Fixed carbon | 60.30 |
| Ash | 7.24 |
| Phosphorus | .01 |
| Sulphur | .69 |
| | 68.24 |

This is the greatest possible yield. Now some of the fixed carbon is burned in the coking operation, and some little volatile matter left in; how much, depends upon the perfection of the process; but the actual percentage will not be far from 66 per cent.; possibly, with good work, more, with poor work less.

There has been considerable discussion near the close of 1885 as to the actual cost of coke to the producer. I have before me three statements of cost. Two are for actual workings for the month of November; the third is the estimate of a miner. They are as follows:

| | No. 1. | No. 2. |
|---|---|---|
| Average cost of coal to ton of coke, including royalty | $0.767 | $0.818 |
| Average labor at ovens | .270 | .328 |
| Average supplies | .073 | .070 |
| Average repairs | .062 | .029 |
| | $1.172 | $1.245 |

The above are actual costs, not estimates, and may be taken to fairly represent the average, not the best located, works. The items of repairs may vary somewhat, as well as the cost of coal; but No. 1 is a fair cost, including royalty, which in these two cases is 16 cents a ton of coke. It will be noted that in neither case is anything allowed for interest on investment, nor for "sinking" the cost of the ovens when the coal is exhausted.

The miners' figures of cost are as follows. They represent the daily expenses of a bank of forty ovens, twenty being drawn each day:

| | |
|---|---|
| Cost of coal (on royalty one-half cent per bushel) | $12.35 |
| Seventy cars of coal (mining 27 cents a car) | 18.90 |
| Boss's wages | 2.00 |
| Oil, posts, rails, etc | 1.50 |
| Charging ovens | 2.00 |
| Leveling | 1.60 |
| Drawing twenty ovens | 11.00 |
| Interest on capital | 2.50 |
| Syndicate's commission | 6.30 |
| | 58.15 |
| Production, $58\frac{8}{10}$ tons coke, at $1.20 | 70.56 |
| Less daily expense | 58.15 |
| | 12.41 |

It will be noted that this makes the cost of getting the coke on the cars ready for shipment $98\frac{9}{10}$. It will be seen that this estimate allows only $1.50 for supplies, or less than 3 cents a ton, as against 7 cents in the above operators' cost. Nothing is allowed for repairs, which are at least 5 cents to 7 cents—as an average, say 6 cents. Nor is there any allowance for labor in mining and hauling the coal other than the miners' wages. Add all these to the miners' cost and it would not come much below the operators' cost.

*The Irwin-Latrobe (Pennsylvania railroad) district.*—One of the most important coking districts in the country, second in point of production to the Connellsville, is what is termed the Irwin-Latrobe (Pennsylvania railroad) district. The production of this district in 1885 was greater than that of any State, except Pennsylvania, and among the districts of this State it was only surpassed by the Connellsville.

This district includes the ovens along the line of the Pennsylvania railroad from Larimer to Blairsville. At many of these ovens coal from the more northerly portion of the Connellsville trough is used. At other ovens the slack from the Pittsburgh bed, in the mines of the Irwin sub-coal basin. One small bank of ovens used slack coal from the mines of the Greensburg basin.

The following are the statistics of the manufacture of coke in the Irwin-Latrobe district for the years 1880 to 1885:

*Statistics of the manufacture of coke in the Irwin-Latrobe (Pennsylvania railroad) district, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 8 | 10 | 11 | 11 | 11 | 11 |
| Ovens built | 757 | 986 | 1,118 | 1,118 | 1,118 | 1,168 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 40 |
| Coal used, short tons | 319,927 | 588,924 | 650,174 | 668,882 | 496,894 | 555,735 |
| Coke produced, short tons | 229,433 | 343,728 | 375,918 | 389,053 | 294,477 | 319,297 |
| Total value of coke at ovens | $397,945 | $548,362 | $536,503 | $422,174 | $311,665 | $346,168 |
| Value of coke at ovens per ton | $1.73 | $1.60 | $1.43 | $1.08 | $1.06 | $1.08 |
| Yield of coal in coke, per cent | 59 | 58 | 58 | 58 | 59 | 57 |

In this district it will be noted that the number of establishments remain the same as in 1884, but there has been an increase of fifty in the number of ovens. The production of coke has increased during the year 24,820 tons; the value, by 2 cents a ton; while the yield of coal in coke, according to the reports, has fallen off 2 per cent.

There is considerable controversy as to the value of the coke from this district as compared with that from Connellsville. There is no question but that the coal, as it comes from the mine, is not as pure as the Connellsville. In some cases it will not coke well at all unless it is crushed and washed, but it is claimed that the washing to which it is subjected removes the impurities, and in some cases makes a coke that is even better than Connellsville, being harder, lower in ash, and with a greater calorific efficiency. An analysis of the coke from the ovens of the Latrobe Coal company, situated in Unity township, Westmore-

land county, shows 89.119 per cent. fixed carbon. Mr. A. S. McCreath says of it: "This coke represents an excellent furnace fuel, carrying rather more than the average percentage of fixed carbon. * * * The physical structure of the coke seems to be very good, and it should be strong enough to carry a heavy burden in the blast furnace." That this coke finds a ready market is evident from the statistics given above, and the increase in production during the past year, though small, could not have taken place at all, in such a depressed condition of trade, had not the coke been a good fuel.

*Alleghany Mountain district.*—The third in importance of the coking districts of Pennsylvania is the Alleghany Mountain. In this district are included the ovens along the line of the Pennsylvania railroad, east of Blairsville, in Cambria and Blair counties and those of Somerset county. In this region were produced 212,242 tons of the 3,991,805 tons of coke made in Pennsylvania, not a very large percentage, but the total amount is in excess of the production of any of the States, except Pennsylvania, Alabama, and West Virginia, and equal to that of Tennessee.

The statistics of the manufacture of coke in the Alleghany Mountain and Somerset district of Pennsylvania for the years from 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in the Alleghany Mountain district of Pennsylvania, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 8 | 9 | 10 | 10 | 12 | 11 |
| Ovens built | 291 | 371 | 481 | 532 | 614 | 523 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 82 |
| Coal used, short tons | 201,345 | 225,563 | 284,544 | 200,343 | 241,459 | 327,666 |
| Coke produced, short tons | 127,525 | 144,430 | 179,580 | 135,342 | 156,290 | 212,242 |
| Total value of coke at ovens | $289,929 | $329,198 | $377,286 | $240,641 | $203,213 | $286,539 |
| Value of coke at ovens per ton | $2.27 | $2.28 | $2.10 | $1.78 | $1.30 | $1.30 |
| Yield of coal in coke, per cent | 63 | 64 | 63 | 68 | 65 | 65 |

Thirty of the ovens reported in 1885 were Belgian. In addition to the ovens some pits were used during all the years covered by this statement. The one hundred Belgian ovens at Johnstown, included in reports of former years, have been torn down. This accounts for the reduced number of ovens, as well as the loss of one establishment. It will be noted that the production of coke in this region has increased fully one-third, a result obtained by no other coking district of any importance in the country, except the Reynoldsville-Rochester district of Pennsylvania.

The character and coking qualities of the coals in this district, as well as the character of the coke, were so fully described in the last volume of "Mineral Resources" as to call for but little in addition. As pointed out in that report, the distance from Johnstown to Altoona, less than 40 miles, is one of the most interesting coking districts in the country.

The coal varies from a true coking coal, making in the beehive oven an admirable blast-furnace coke, to a dry burning coal that cannot be coked to advantage in the beehive oven, requiring the heat of the Belgian oven to coke it properly. In this same district can be studied the three typical methods of coking—in pits, in beehive ovens, and in Belgian (Coppée) ovens. The experiments made for the Cambria Iron Company by Mr. John Fulton, its mining engineer, in the use of different coals and methods of coking, as well as those relating to the value of cokes, have been the most careful and thorough of any made in this country. They have already been of great value, and must be of increasing importance.

Most of the coke made is for blast furnace use, being in demand not only at the furnaces in this section, but at the anthracite furnaces of the East. The coal chiefly used is from bed B, or the Miller seam. This coke resembles the Connellsville, is sonorous, cellular, and tenacious, reasonably pure, and has great heating power. Analyses of these cokes were given in "Mineral Resources for 1883–1884." Another, made by the Gallitzin Coal and Coke Company, from samples taken by Mr. McCreath from shipments to the Pennsylvania Steel Company, at Steelton, is as follows:

*Analysis of Gallitzin (Pennsylvania) coke.*

| | Per cent. |
|---|---|
| Moisture | .108 |
| Volatile matter | .790 |
| Fixed carbon | 90.687 |
| Sulphur | .927 |
| Ash | 7.488 |
| | 100.000 |

At Conemaugh station, at the spiegel furnace of the Cambria Iron Company, there is a bench of thirty Belgian ovens making coke from the Lemon coal bed. This is a dry coal, making rather a soft coke, which could not be used in a blast furnace making ordinary pig iron, but is well adapted to use in the manufacture of spiegel.

*The Snow Shoe district.*—There has been a marked increase both in the number of ovens and the make of coke in the Snow Shoe district in 1885 over any previous year since coke making began to be an industry in this region in 1880. During the year the Irvona Coal Company has erected ovens at Coalport, and has begun coking coal from what is known locally as the Big Moshannon vein. The vein as mined by this company is 4½ to 5¼ feet thick. The coal is run over a 2-inch screen 20 feet long, the screenings being coked. The company has eighty ovens.

Analyses of the coal and coke, by Booth, Garrett & Blair, chemists, are as follows:

*Analysis of Irvona coal (Big Moshannon vein).*

| | Per cent. |
|---|---|
| Fixed carbon | 71.752 |
| Volatile matter | 21.600 |
| Ash | 5.615 |
| Water at 212° F | 1.033 |
| | 100.000 |

*Analysis of Irvona (Pennsylvania) coke.*

| | Per cent. |
|---|---|
| Fixed carbon | 88.994 |
| Volatile matter | .670 |
| Ash | 10.173 |
| Water at 212° F | .163 |
| | 100.000 |
| Sulphur | .775 |

This coke is used entirely in the eastern markets, and on account of the unappreciable amount of phosphorus which it is claimed to have is practically adapted to the manufacture of Bessemer pig iron.

In May of 1885 the ovens reported upon last year, which were operated by Berwind, White & Co., passed into the possession of the Lehigh Valley Coal Company, which increased their number to one hundred and sixty-five.

The following is an analysis of the coke, Booth, Garrett & Blair being the chemists, and making their own selection for analysis:

*Analysis of the Lehigh Valley Coal Company's Snow Shoe (Pennsylvania) coke.*

| | Per cent. |
|---|---|
| Fixed carbon | 90.27 |
| Volatile matter | .46 |
| Ash | 8.91 |
| Moisture | .36 |
| | 100.00 |

From the following statement it will be seen that the number of ovens at the close of 1885 in the Snow Shoe district was two hundred and forty-five, an increase over 1884 of one hundred and eighty-five. The make of coke was 48,103 short tons, an increase over 1884 of 24,672 tons, or over 100 per cent. The statistics of the manufacture of coke in the Snow Shoe district of Pennsylvania for the years from 1880 to 1885 are:

*Statistics of the manufacture of coke in the Snow Shoe district, Pennsylvania,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 1 | 2 | 1 | 1 | 1 | 2 |
| Ovens built | 0 | 50 | 50 | 60 | 60 | 245 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 200 | 20,025 | 25,000 | 26,500 | 33,000 | 69,720 |
| Coke produced, short tons | 100 | 13,350 | 17,160 | 18,696 | 23,431 | 48,103 |
| Total value of coke at ovens | $200 | $22,695 | $27,406 | $28,044 | $32,849 | $70,331 |
| Value of coke at ovens, per ton | $2 | $1.70 | $1.60 | $1.50 | $1.40 | $1.46 |
| Yield of coal in coke, per cent | 50 | 67 | 69 | 71 | 71 | 69 |

*Broad Top district.*—This district, and its coals and cokes, were quite fully described in the last report. In it are included all of the works in Bedford and Huntingdon counties. At these five works there were, at the close of 1885, a total of five hundred and thirty-seven ovens, an increase during the year of eighty-four. Of the five hundred and thirty-seven ovens, two hundred and five are Belgian, or flue ovens, the others beehive. The Belgian oven is not held in such high esteem for coking the coal of this district as formerly. One of the works that has been operating Belgian ovens built eighty four beehive ovens during the year. One establishment with eighty-eight ovens has been idle the entire year. It will be noticed that there has been a falling off in the production during 1885. This is due to the idleness of the Kemble Iron Company the entire year. The coke made in this district is without exception for use in the blast furnaces with which the coke works are connected.

The statistics of the production of coke in the Broad Top region of Pennsylvania in the years from 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in the Broad Top region, Pennsylvania,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 5 | 5 | 5 | 5 | 5 | 5 |
| Ovens built | 188 | 188 | 293 | 343 | 453 | 537 |
| Ovens building | 105 | 105 | 50 | 110 | 0 | 0 |
| Coal used, short tons | 92,894 | 111,593 | 170,637 | 220,932 | 227,954 | 190,836 |
| Coke produced, short tons | 51,130 | 66,560 | 105,111 | 147,154 | 151,959 | 112,073 |
| Total value of coke at ovens | $123,748 | $167,074 | $215,079 | $271,692 | $264,569 | $185,656 |
| Value of coke at ovens, per ton | $2.40 | $2.51 | $2.05 | $1.84 | $1.74 | $1.65 |
| Yield of coal in coke, per cent | 55 | 59 | 62 | 66 | 66 | 58 |

The value given in the above table is in some cases the cost at the ovens; in others, an assumed price over cost. So little of the coke is sold that no market price can be given. The prices for 1880 range from $2.25 to $3.05; for 1881, from $2.25 to $2.95; for 1882, from $1.64 to $2.86; for 1883, from $1.53 to $2.61; for 1884, from $1.48 to $2.61, and for 1885, from $1.34 to $2 per ton.

It is claimed that the coke from Broad Top coal is equal in furnace work to the Connellsville.

Some analyses were given in the last volume of "Mineral Resources." The following are additional ones from another establishment:

*Analyses of Broad Top (Pennsylvania) cokes.*

| | Powelton pit coke. | Powelton oven coke. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Fixed carbon | 89.91 | 89.43 |
| Volatile matter | .25 | 2.13 |
| Moisture | .20 | .43 |
| Ash | 9.13 | 7.20 |
| Sulphur | .51 | .69 |
| Total | 100.00 | 99.88 |

In the Belgian ovens, at the Powelton works, 24, 48, 60, and 72 hour coke is made, and all seem equally good. In the beehive 48 and 72 hour only are made.

*The Pittsburgh district.*—In this district are included the coke ovens in Allegheny and Washington counties, and those on the Monongahela river in Fayette county. But little coke has been made for some years on the Monongahela river above Pittsburgh, though considerable slack coal from the mines of the First, Second, and Third pools is coked at Pittsburgh. For this reason, as most of the ovens are in ruins, they are regarded as abandoned.

In this district no lump coal or run of the mines is used in coking, with possibly the exception of one works. The coal is from the slack of the Pittsburgh bed. While the coke is as pure as that made at Connellsville, which is from the same bed, indeed it is freer from ash, its physical properties are not as good. It is too porous and not as strong a fuel.

The statistics of the manufacture of coke in the Pittsburgh district of Pennsylvania are as follows for the years from 1880 to 1885:

*Statistics of the manufacture of coke in the Pittsburgh district, Pennsylvania,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 21 | 21 | 21 | 20 | 20 | 17 |
| Ovens built | 534 | 538 | 557 | 542 | 535 | 416 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 4 |
| Coal used, short tons | 194,393 | 178,509 | 114,956 | 119,310 | 97,367 | 91,101 |
| Coke produced, short tons | 105,974 | 96,310 | 64,779 | 66,820 | 53,357 | 46,930 |
| Total value of coke at ovens | $254,500 | $206,965 | $134,378 | $126,020 | $99,911 | $72,509 |
| Value of coke at ovens, per ton | $2.40 | $2.15 | $2.07 | $1.89 | $1.87 | $1.55 |
| Yield of coal in coke, per cent | 55 | 54 | 61 | 56 | 55 | 51.5 |

At one of the works in this district persistent efforts have been made, through a series of years, to use some form of the Belgian flue oven, and after many trials some measure of success was attained by using a modified form. These have now been abandoned, however, and beehive ovens erected in their stead. The cost of repairs on the Belgian ovens was too large to make the coke produced in them an economical fuel.

*Beaver district.*—The coke industry in the Beaver district, in which are included the ovens in Beaver and Lawrence counties, is of but little importance. The largest bank of ovens, and the only one of any size, that at New Castle, which comprises eighty of the eighty-nine ovens in the district, has not been in operation for some years. The ovens at the Wampum furnace, at Wampum, have been idle for a long time, and are now in ruins. Even the eighty ovens at New Castle could not be operated without extensive repairs, practically without rebuilding. The only ovens in operation the past year were four at two works in Beaver Falls, which were run to supply a local trade. Even these were idle at the close of the year, natural gas having entirely superseded coal and coke as fuels in these markets.

The following are the statistics of the manufacture of coke in the Beaver district of Pennsylvania for the years from 1880 to 1885:

*Statistics of the manufacture of coke in the Beaver district, Pennsylvania,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 5 | 5 | 5 | 5 | 4 | 4 |
| Ovens built | 106 | 106 | 106 | 107 | 89 | 89 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 8,013 | 6,887 | 11,699 | 19,510 | 2,250 | 686 |
| Coke produced, short tons | 4,880 | 4,333 | 7,960 | 12,395 | 1,390 | 438 |
| Total value of coke at ovens | $10,150 | $9,013 | $15,124 | $21,062 | $2,168 | $696 |
| Value of coke at ovens, per ton | $2.08 | $2.08 | $1.90 | $1.70 | $1.56 | $1.59 |
| Yield of coal in coke, per cent | 61 | 63 | 68 | 64 | 62 | 63 |

*Alleghany Valley district.*—In this district are included the coke works in Armstrong and Butler counties, and one of those in Clarion county, the other ovens in the latter county being included in the Reynoldsville-Rochester district.

In Armstrong county three works were reported as in existence at the time of the last report. At but one of these, that of the Kittanning Iron Company, Limited, are there ovens, the coke at the other two having been made on the ground. As the furnaces at which it was used have been out of blast for some years, these two works are dropped from the list.

In Butler county there are two works, one of which, the Keystone Coal and Coke Company, at Roy, was completed late in 1885. At this works the coke made is from washed slack, a Stutz three-sieved washer, with a capacity of 500 tons a day, being used. The coke is hard and firm, and has an excellent reputation. The chief markets are Buffalo, New York, and New Castle, Pennsylvania. Its chief uses are for foundry and blast-furnace purposes. It is stated that the New Castle furnace men have a standing order for all they can get. The others works in the county, the Union Coal and Coke Company, limited, at Coaltown, has been in operation since 1882. The coke finds a market in northwestern Pennsylvania and eastern Ohio, at foundries, iron works, etc.

The only works in Clarion county included in this district, the Red

Bank, has made no coke for more than two years, the blast furnace in which it is used having been idle for that time.

The following are the statistics of the manufacture of coke in the Alleghany Valley district of Pennsylvania for the years from 1880 to 1885:

*Statistics of the manufacture of coke in the Alleghany Valley district, Pennsylvania, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 5 | 5 | 6 | 6 | 7 | 5 |
| Ovens built (*a*) | 97 | 109 | 159 | 159 | 209 | 208 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 45,355 | 55,676 | 76,000 | 64,810 | 55,110 | 28,630 |
| Coke produced, short tons | 23,470 | 29,650 | 41,897 | 34,868 | 31,430 | 15,326 |
| Total value of coke at ovens | $49,068 | $64,664 | $80,294 | $62,982 | $54,859 | $30,151 |
| Value of coke at ovens, per ton | $2.10 | $2.18 | $1.92 | $1.81 | $1.75 | $1.97 |
| Yield of coal in coke, per cent | 52 | 53 | 55 | 54 | 57 | 53.5 |

(*a*) Two establishments have no ovens, burning their coke in ricks.

*The Reynoldsville-Walston district.*—In the last report this district was called the "Low Grade or Bennett's Branch," from the fact that most of the ovens were along the Low Grade division of the Alleghany Valley railroad. It is believed that the name now given, the Reynoldsville-Walston, from the localities of its chief banks of ovens, will more correctly describe it.

In this district are included all the ovens on the Rochester and Pittsburgh railroad, as well as those on the Low Grade division of the Alleghany Valley railroad. It is among the most interesting and growing of the coking districts of the country. The coke from this section is crowding the Connellsville out of some markets that it at one time held exclusively, and is competing with it in others, as at Chicago.

The following are the statistics of the manufacture of coke in the Reynoldsville-Walston district of Pennsylvania for the years from 1880 to 1885:

*Statistics of the manufacture of coke in the Reynoldsville-Walston district, Pennsylvania, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 3 | 4 | 5 | 6 | 7 | 8 |
| Ovens built | 117 | 125 | 177 | 229 | 321 | 600 |
| Ovens building | 0 | 2 | 0 | 0 | 0 | 143 |
| Coal used, short tons | 45,055 | 99,489 | 87,314 | 76,580 | 159,151 | 183,806 |
| Coke produced, short tons | 28,090 | 44,260 | 44,709 | 37,044 | 78,646 | 114,409 |
| Total value of coke at ovens | $46,359 | $80,785 | $80,339 | $65,584 | $113,155 | $153,795 |
| Value of coke at ovens, per ton | $1.65 | $1.85 | $1.80 | $1.77 | $1.44 | $1.34½ |
| Yield of coal in coke, per cent | 62 | 44 | 51 | 48 | 49 | 62 |

The great increase in the yield of coal in coke, shown in the table, is no doubt due to the fact that in former years the production was to some extent experimental, and also that a much larger proportion of the coke made was from washed slack.

The coals and cokes of the Low Grade division of the Alleghany Valley railroad were described quite fully in the last report. In addi-

tion, the following analysis of Du Bois coke, from the works of Bell, Lewis & Yates, may be given:

*Analysis of Du Bois (Pennsylvania) coke.*

| | Per cent. |
|---|---|
| Fixed carbon | 87.294 |
| Volatile matter | .804 |
| Water | .096 |
| Ash | 10.624 |
| Sulphur | 1.182 |
| | 100.000 |
| Phosphorus | .011 |

The market for this coke is chiefly at Buffalo and in Canada, though it is sent to Chicago, where it competes with Connellsville.

Of the six coke works along the Low Grade division, two made no coke the entire year, and two others but little until September.

Along the line of the Rochester and Pittsburgh railroad there are two coke works, one built in 1885 in Elk county, and the other, that of the Rochester and Pittsburgh Coal and Iron Company, at Walston, Jefferson county. Outside of the Connellsville region this is the largest coke works in Pennsylvania, and with the exception of some in the Connellsville region, and of the Tracy City works of the Tennessee Coal, Iron and Railroad Company, the largest in the United States. At the close of 1885 it was running three hundred and fifty-seven ovens. This number is to be increased to five hundred in the spring of 1886. The growth of this works is remarkable, in view of the depression in the trades consuming coke. On December 31, 1883, this company had fifty-one ovens in operation; at the close of 1884 the number was one hundred and fifty, and three hundred and fifty-seven at the close of 1885.

The Walston Coke Works, of the Rochester and Pittsburgh Coal and Iron Company, are located in the Punxsutawney coal field in Jefferson county. The coal used is from the Lower Freeport bed, which in the mines of this company is 6 feet thick, without slate partings and displaying unusual coking qualities. Unlike much of the coke made in this district, the coal is not washed, but coked in its natural state, as is the Connellsville. The water used in drenching the coke as it comes from the ovens is from two wells, 300 feet deep, sunk near the ovens.

The Walston coke is claimed to possess the characteristics of a good coke in an eminent degree, having a bright silvery luster (indicating freedom from sulphur); a resonant metallic ring when struck (indicating hardness); an open cellular structure, without sacrifice of weight, which facilitates its impregnation with the furnace gases; hardness and tenacity, sustaining without crushing the blast and heavy burden of a high furnace stack, and a composition as dry and as free as possible from impurities, and especially from phosphorus. To what extent it has

these characteristics will be evident from the following tables which show the results of some physical tests of the coke, and also its chemical composition. The physical tests were made by Mr. John Fulton, of the Cambria Iron Company, and the chemical analyses by Mr. A. S. McCreath and and Mr. T. T. Morrell. The samples of Walston coke tested were both 48-hour and 72-hour:

TESTS OF 72 HOUR WALSTON (FOUNDRY) COKE.

*Physical analysis.*

| Locality. | Grams in one cubic inch. | | Pounds in one cubic foot. | | Percentage. | | Compressive strength per cubic inch (4) ultimate strength. | Height of furnace charge, supported without crushing. | Order in cellular space. | Hardness. | Specific gravity. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dry. | Wet. | Dry. | Wet. | Coke. | Cells. | | | | | |
| Standard coke, Connellsville | 12.46 | 20.25 | 47.47 | 77.15 | 61.53 | 38.47 | 284 | 114 | I | 3.5 | 1.500 |
| Walston coke | 16.63 | 23.4 | 63.36 | 89.15 | 71.07 | 28.93 | 270 | 109 | I | 3.7 | 1.900 |

*Chemical analysis.*

| Locality. | Fixed carbon. | Moisture. | Ash. | Sulphur. | Phosphorus. | Volatile matter. |
|---|---|---|---|---|---|---|
| Standard coke, Connellsville | 87.46 | 0.49 | 11.32 | 0.69 | 0.029 | 0.011 |
| Walston coke (A. S. McCreath, 72-hour coke) | 88.476 | .148 | 9.731 | .951 | .008 | .692 |

*Coke analyses.*

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Water | 0.064 | 0.234 | 0.145 |
| Volatile matter | .794 | .552 | .731 |
| Fixed carbon | 88.293 | 88.869 | 88.266 |
| Sulphur | 1.017 | 1.012 | .826 |
| Ash | 9.832 | 9.333 | 10.032 |
| Totals | 100.000 | 100.000 | 100.000 |
| Phosphorus | ..... | .0085 | .0080 |

*Walston coal.*

| | Per cent. |
|---|---|
| Water | 0.983 |
| Volatile matter | 30.933 |
| Fixed carbon | 60.916 |
| Sulphur | 1.063 |
| Ash | 6.105 |
| | 100.000 |
| Phosphorus | 0.0065 |

Regarding this coke Mr. Fulton states: "These tests show a compact, hard-bodied coke, harder than the average Connellsville standard. This coke has been carefully prepared and cannot be distinguished from Connellsville coke. The cells are a little less than the Connellsville,

but the difference is not large enough to induce any marked change in blast furnaces. This coke is capable of sustaining fast driving in the largest blast furnaces. It will prove an excellent fuel for this and kindred uses."

The other establishment in this district is at Dagus mines in Elk county. At this works there are thirty-six ovens, twenty-four of which were erected in 1885. The coal is washed with a Stutz washer. The plant is, in a measure, experimental. About one third of the production is sold as crushed coke.

*The Blossburg district.*—This district, and its coals and cokes, were so thoroughly described in the last report as to render unnecessary any description here. The Blossburg coal field is one of the small detached basins into which the northern limit of the Appalachian field is broken.

At the close of 1885 but two hundred and ninety-six ovens were reported in this district, as against three hundred and forty-four at the close of 1884. One of the works that in 1884 gave the number of its ovens as one hundred and forty-four returns but ninety-six in 1885. There also has been a decline in the production of coke in 1885.

The following are the statistics of the manufacture of coke in the Blossburg district of Pennsylvania for the years from 1880 to 1885:

*Statistics of the manufacture of coke in the Blossburg district, Pennsylvania,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 1 | 1 | 1 | 2 | 2 | 2 |
| Ovens built | 200 | 200 | 200 | 344 | 344 | 296 |
| Ovens building | 0 | 0 | 0 | 0 | 32 | 0 |
| Coal used, short tons | 72,520 | 88,055 | 100,119 | 71,028 | 62,365 | 46,489 |
| Coke produced, short tons | 44,836 | 56,085 | 64,526 | 44,690 | 39,043 | 26,975 |
| Total value of coke at ovens | $134,500 | $168,250 | $193,500 | $122,450 | $93,763 | $59,423 |
| Value of coke at ovens, per ton | $3 | $3 | $3 | $2.74 | $2.40 | $2.17 |
| Yield of coal in coke, per cent | 62 | 64 | 64 | 63 | 63 | 58 |

## TENNESSEE.

Tennessee held the same relative rank, the fourth, in the list of coke-producing States in 1885 as in 1884. Since the close of 1884 there has been an increase in the number of ovens in the State, the coke product, however, remaining about the same as in 1884.

The statistics of the manufacture of coke in Tennessee for the years 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in Tennessee,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 6 | 6 | 8 | 11 | *a*13 | 12 |
| Ovens built | 656 | 724 | 861 | 992 | 1,105 | 1,387 |
| Ovens building | 68 | 84 | 14 | 10 | 175 | 36 |
| Coal used, short tons | 217,656 | 241,644 | 313,537 | 330,961 | 348,295 | 412,538 |
| Coke produced, short tons | 130,609 | 143,853 | 187,695 | 203,691 | 219,723 | 218,842 |
| Total value of coke at ovens | $316,607 | $342,585 | $472,505 | $459,126 | $428,870 | $398,459 |
| Value of coke at ovens, per ton | $2.42 | $2.38 | $2.52 | $2.25 | $1.95 | $1.82 |
| Yield of coal in coke, per cent | 60 | 60 | 60 | 62 | 63 | 53 |

*a* One works made coke in pits.

The most noticeable feature in the report for 1885, as compared with that for 1884, is the reduction in percentage yield of coal in coke from 63 per cent. in 1884 to 53 per cent. in 1885. There is no explanation to offer as to the great difference. In both cases the statements are based upon returns from the producers. The figures for 1885 are corroborated by a remark in a letter from one of the largest producers in the State: "Two tons of coal yield, in Tennessee, one ton of coke."

At three of the works, with an aggregate of one hundred and sixty ovens, no coke was made during the year; at others, only a part of the ovens were in operation at any time, while others ran very irregularly. Most of the coke made in this State is for use in blast furnaces, and the depression in the iron industry has had its effect upon the coke business. At one works, that of the Tennessee Coal, Iron and Railroad Company, at Tracy City, one hundred and thirty-five ovens have been built during the year. The ovens of this same company, at Victoria, were not lighted the entire year, and their number has been reduced from one hundred and ten to seventy. The ovens of the Dayton Coal and Iron Company, limited, have been fired during the year, but have not produced near their capacity.

As indicated above, most of this coke is for blast-furnace consumption; but the product of certain works has an excellent reputation for foundry purposes, and some also goes to the smelters of Arizona and New Mexico.

There has been considerable discussion during the past year as to the quality of Tennessee coke. Prof. H. E. Colton, in a letter to the *Iron Age*, speaking of the coals and cokes of this State, says: "No coke of commercial importance which could take the place of standard Connellsville has yet been manufactured in the South. There are cokes of local importance of good quality, but, with a less distance to the great West, and a possibility of lower freight rates, Connellsville still has no formidable rival from the southern division of the Appalachian coal field. Whether this is ever to be changed is a matter of doubt. The State of Tennessee was the first in the South to turn coal into coke for the manufacture of iron, and the success at Rockwood began a new era in the coal industry of the South. The State has an area of 5,100 square miles underlaid with coal, in a large part of which there are fully eleven workable seams, yet for all commercial consideration it may be said that all the coke made is from one seam, and that one the same from which it was first made at Rockwood. Every one acquainted with iron making in Tennessee knows that it is not a first-class coke. The seam of coal from which it is made is known as the Sewanee seam, it is the correlative of Seam B of the Pennsylvania classification, and covers a greater area and is available at more points than any seam of coal in the southern States. It is only about 30 feet above the great conglomerate, ranges from 2 to 7 feet (usually about 3½ feet) in thickness, and is everywhere easily and cheaply mined. It occurs both in the hori-

zontal formation and in the pitched rocks of Molder's ridge from Dayton to Cumberland Gap. In chemical composition the coal contains from 62 to 64 per cent. of fixed carbon, 26 to 29 per cent. of volatile matter, and 9 to 11 per cent. of ash. The coke made from it usually contains 83 to 84 per cent. of carbon and 14 to 15 per cent. of ash. It is very free from sulphur and contains but little phosphorus. Why, then, is it not a first-class coke? Even if its proportion of ash were less it would not be, for it has not the physical structure. If it has the porosity, it has not the coherence. But it is an important factor in the iron making, present and future, of Tennessee.

"The equivalent of the Pittsburgh coal bed in the Tennessee series is the seam now worked at Coal creek and at Poplar creek, and which was once worked at Caryville. It does not exist to any great extent, if at all, southwest of Emory river, and it is beneath water level from Caryville 10 miles northwestward, where it ceases in that direction. As opened in Tennessee, it has the characteristics of the Pittsburgh bed in its western part, at Irwin, for instance; but so far no part of it has been positively determined as having identity with the seam in the region classed as Connellsville. It is claimed, however, that in its northwestern prolongation on the Crooked Fork, in Morgan county, the coal of this seam resembles Connellsville in structure. As existing at Coal creek, and mined there, this seam is from 4 to 5 feet in thickness of clear coal, there being several shale partings. The top is a hard coal which does not coke well, while the lower layer makes a first-class coke. No sufficient test of this coal for coke making has ever been made. Badly-constructed and badly-managed experimental ovens have at intervals been erected, but as a natural consequence no good results have been attained. There is no reason why as good coke should not be made there as is made at Irwin, Pennsylvania, the works near which place supply nearly half of the coke used at the blast furnaces of Carnegie Bros. & Co.

"At Poplar creek more systematic operations for making coke from this seam of coal have been conducted. The Oakdale Iron Company converted this coal into coke for use in its furnace for more than a year, and the stoppage of the furnace was in no way due to the character of the coke. Yet the stack was comparatively a low one, and nothing was proved going toward a solution of the problem whether it was a coke that would work well continuously in tall stacks and carry heavy burdens. Its appearance indicated that with proper handling the physical structure would be good, but unfortunately no proper tests were made on this point. The chemical composition of the Coal Creek and Poplar Creek coals is very similar to Connellsville, they having from 57 to 60 per cent. of fixed carbon, but in volatile matter they are higher and in ash much lower. There is every possibility, however, that the difference mainly exists from the mode in which the samples were taken, Connellsville having been taken by Mr. McCreath from a thorough cut of

the whole seam, and the Coal and Poplar Creeks, no doubt, a picked and isolated lump. The Oakdale Company had sixty-four ovens, and also made considerable coke in pits. The coke made broke into long pieces, had no cross cracks, and the cells appeared sufficiently open for good working in the furnace without giving a spongy texture and weakness. The record of the furnace is not a test, as it was for much of the time badly handled; the books, however, show one month's run with an average of 67 bushels of coke to the ton of pig. This coke was never transported any distance in quantity, so that no test of loss in that way was had. It is possible, as stated, that the northwestern extension of this seam will afford a coal from which a coke nearly or quite the equal of standard Connellsville can be made.

"Above this seam of coal exist at least seven others over 3 feet in thickness. Whether in any of these is a coal which will make a coke the equal of Connellsville is unknown. They are practically unopened and unexplored. During investigations for a private company I found one seam which, from its size, could have been mined cheaply, and the physical structure of the coal indicated that it would make a good coke, while this idea was strengthened by experiments in the open air. Two barrels of this coal were sent to Mr. A. S. McCreath for analysis. His result was:

| | Per cent. |
|---|---|
| Volatile hydrocarbons | 39.023 |
| Fixed carbon | 48.229 |
| Sulphur | 3.208 |
| Ash | 8.275 |
| Phosphorus | .020 |

"The coke made contained:

| | Per cent. |
|---|---|
| Carbon | 82.656 |
| Sulphur | 3.163 |
| Ash | 14.181 |
| Phosphorus | .034 |

"His comments on this are: 'The physical character of the coke is fair, although it may prove rather spongy and weak for use in large furnaces, but chemically it carries an excessive amount of both sulphur and ash. The sulphur exists in the coal for the most part as iron pyrites, sometimes in masses one-quarter of an inch in thickness. Its general occurrence is such as to lead to the impression that it may be present in the form of a "sulphur tinder," near either the roof or floor of the coal bed. Much of the coal is comparatively free from sulphur. A different sampling of the coal bed might therefore result in locating the excessive amount of iron pyrites in a particular part or bench of the bed, which could be rejected in mining operations. This would not only eliminate a large portion of the sulphur, but it would materially affect the per-

centage of ash, for, assuming all the sulphur to be present in the form of iron pyrites, nearly one-half of the ash must consist of oxide of iron, resulting from the iron pyrites.'

"His remarks as to the sampling and position of the iron pyrites are correct. The pyrite exists in plates and balls in a slate, parting about 1 foot from the bottom, and can be easily taken out in mining, but in sending the sample a full cut from top to bottom of the seam was made without effort at selection. This seam of coal is 6 feet thick, has an excellent roof and floor, and can be mined at very low cost; hence, if not too high in volatile matter, it offers an opportunity for the production of a cheap coke. The owners of the land from which the above sample was taken have not chosen to pursue the investigation further, and the seam, though known to exist, has not yet been opened on any other property. If in this or some other of the seams above Coal H, of Coal creek and Poplar creek and Crooked Fork, there does not exist a good coking coal, there is not any such to be had in the Tennessee field, unless it mayhap be discovered in the unexplored Walnut Mountain field, which is the southwest extension of the Flat Top coal field of Virginia. In the future the cost of producing and characteristics of the cokes noted, as well as of some minor seams not here mentioned, will be discussed also as far as possible to ascertain their action in the furnaces."

In a further communication Professor Colton says:

"Some have already taken exception to my statement that there is not any first-class coke of commercial importance in the South. In further explanation of that statement it may be said that no coke of first-class quality is manufactured in the South in sufficient quantities to make any appreciable competition against the product from the Connellsville region. It is admitted that the Etna Company, in Tennessee, make a coke of very superior quality for foundry use, but if they were to attempt to produce a coke for blast furnaces they would do so at a loss, for it could not be sold at a price low enough to admit of any blast furnace using it. The seam of coal there mined is on the average thin as well as variable in its thickness. The product of these coke works is only about 8,000 tons per annum. Again, a very good blast-furnace coke has been made at the Crooke Coal Company's mines, near Glen May, on the Cincinnati Southern railway. The amount made, however, has been small, and it could not be placed in Chattanooga at a price which would justify any furnace in using it solely. It probably approaches nearer to a standard coke than any yet made in Tennessee. Until a coal is found which will make a coke that has the qualities possessed by the Connellsville product, and that coal is of such thickness that it can be cheaply mined and the coke produced can be sold at such a minimum price that it can be sent South, West, or North in competition with the Connellsville product, until then no coke in the South is of sufficient importance to be calculated in the estimate for commercial supply for the country at large."

Replying to Professor Colton's statement as to Poplar Creek coke, a correspondent of the same journal, who signs himself E. C. L., says: "He is certainly in error in his judgment in regard to the coke made from Poplar Creek coal and used at the Oakdale Iron Works. The writer was frequently at the works during the time the furnace was in blast, and gave especial attention to the working of the coke in the furnace, and can safely say it answered all expectations, carrying a burden said to be fully equal to that of Connellsville coke. That the coke made by us was perhaps not as solid and compact as Connellsville coke we do not deny, but the cause of this was that the coke was put into the ovens just as it came from the mines, in lumps frequently so large that they had to be forced through the oven openings, a peculiarity of the coal being that when the lumps became heated the coal disintegrated, like slacking lime. The coke became fingery, and, while it probably would not have borne transportation a long distance, it answered every purpose for the furnace. Several experiments were made by using only the slack coal free from lumps. The product was a solid, compact mass of coke which would bear transportation to almost any distance and carry a burden equal to any made. The following is the analysis made by Messrs. Potter & Riggs, of Saint Louis:

| | Coal. | Coke. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Moisture | 1.62 | 0.27 |
| Volatile matter | 39.25 | .95 |
| Fixed carbon | 57.67 | 90.06 |
| Ash | 1.48 | 8.76 |
| Sulphur | .445 | 1.643 |

The following is a report made by Regis Chauvenet & Bro.:

| | Coal. |
|---|---|
| | *Per cent.* |
| Moisture | 1.24 |
| Volatile matter | 39.83 |
| Fixed carbon | 56.12 |
| Ash | 2.85 |

"This coal will yield 58.93 per cent. coke, containing fixed carbon, 95.24, and ash, 4.76. It will be seen that there is some difference in the analyses made by Mr. McCreath and those of the above. During the past summer we had several ovens of coke made from the coal mined from our new entry, which we are driving at Poplar creek, under what is known as Big Bushy mountain. We have had no analysis made of the coke."

## UTAH.

As was stated in the previous reports, the attempts to manufacture coke in Utah on a commercial scale have so far proved unsuccessful. Some years ago twenty coke ovens of the Belgian (Coppée) type were erected in the San Pete valley, and some coke made, but these ovens

have not been operated for three years. The Territory possesses large bodies of iron ore, and many investigations have been undertaken to ascertain the probabilities of successful iron manufacture, using as fuels cokes from the coals which exist in several localities, but so far without finding a coke that seemed to answer the purpose of a blast-furnace fuel.

At the Pittsburgh meeting (February, 1886) of the American Institute of Mining Engineers, Prof. George W. Maynard, of New York, gave the following analyses of coals and cokes from two localities in this Territory:

*Analyses of Utah coals and coke.*

| | Cedar City. | Castledale. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water at 212° Fahrenheit | 3.562 | 3.426 |
| Volatile matter | 43.669 | 42.814 |
| Fixed carbon } | 43.102 | 47.810 |
| Sulphur } | | |
| Ash | 9.727 | 5.950 |
| | 100.000 | 100.000 |
| Coke | 52.835 | 53.760 |
| Color of ash | Pink gray. | Reddish gray. |

The Cedar City coal was quite coherent and hard; the Castledale much less coherent. The analysis of Cedar City coke was as follows:

| | Per cent. |
|---|---|
| Water and volatile matter | 1.417 |
| Fixed carbon | 76.706 |
| Sulphur | 5.270 |
| Ash | 16.607 |

This coke is of but little value as a fuel, because of the large amount of ash it contains and because of the excessive percentage of sulphur.

The statistics of the manufacture of coke in Utah for the years 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in Utah, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 1 | 1 | 1 | 1 | 1 | 1 |
| Ovens built (all Coppée) | 20 | 20 | 20 | 20 | 20 | 20 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used in ovens, short tons | 2,000 | 0 | 500 | 0 | 0 | 0 |
| Coke produced, short tons | 1,000 | 0 | 250 | 0 | 0 | 0 |
| Total value of coke at ovens | $10,000 | 0 | $2,500 | 0 | 0 | 0 |
| Value of coke at ovens, per ton | $10 | 0 | $10 | 0 | 0 | 0 |
| Yield of coal in coke, per cent | 50 | 0 | 50 | 0 | 0 | 0 |

## VIRGINIA.

The only coke made in Virginia in 1885, from coal mined in the State, was at Pocahontas, from Flat Top coal, by the Southwest Virginia Improvement Company. There is, in addition to the Pocahontas ovens, a

bank of one hundred and fifty ovens at Low Moor, in Alleghany county, just across the border from West Virginia, but as these ovens draw their entire supply of coal from the New River district of West Virginia, being located, only for convenience, at Low Moor, near the blast furnace in which their product is consumed, their product is reported in West Virginia.

The Pocahontas coal and the coke made from it were described at length in the last report. There has been no increase in the number of ovens during the year. The production has fallen off about 22 per cent. by reason of the decreased demand for blast-furnace coke.

The statistics of the manufacture of coke in Virginia, from Virginia coal, for the years from 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in Virginia, 1880 to 1885.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 0 | 0 | 0 | 1 | 1 | 1 |
| Ovens built | 0 | 0 | 0 | 200 | 200 | 200 |
| Ovens building | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal used, short tons | 0 | 0 | 0 | 39,000 | 99,000 | 81,899 |
| Coke produced, short tons | 0 | 0 | 0 | 25,240 | 63,600 | 49,139 |
| Total value of coke at ovens | 0 | 0 | 0 | $44,345 | $111,300 | $85,993 |
| Value of coke at ovens, per ton | 0 | 0 | 0 | $1.75 | $1.75 | $1.75 |
| Yield of coal in coke, per cent | 0 | 0 | 0 | 65 | 64¼ | 60 |

An analysis of Pocahontas coke, representing "an average of the charge of a 12 by 6 feet beehive oven coked seventy-two hours," is given in *The Virginias*. It is by Dr. Henry Frœhling, of Richmond:

*Analysis of Pocahontas (Virginia) coke.*

| | Per cent. |
|---|---|
| Fixed carbon | 93.84 |
| Volatile combustible matter | .59 |
| Moisture | .29 |
| Ash | 5.28 |
| Total | 100.00 |

The analysis of the ash is as follows:

| | Per cent. |
|---|---|
| Silica | 2.780 |
| Alumina | 1.009 |
| Ferric oxide | .881 |
| Lime | .341 |
| Magnesia | .016 |
| Phosphoric acid | .018 |
| Sulphuric acid | .158 |
| Potash | .068 |
| Manganese | Trace. |
| | 5.271 |

Mr. Austin Farrell, superintendent of the Glamorgan Iron Company at Lewiston, Pennsylvania, speaks of Virginia coke from the Pocahon-

tas coal as being fairly strong and dense, but intimates that its quality could be greatly improved by a little more care in the preparation of the coal and in conducting the coking process. He gives the following as the average of several analyses of this coke covering the deliveries of a period of six months:

*Analysis of Pocahontas (Virginia) coke.*

| | Per cent. |
|---|---|
| Fixed carbon | 90.02 |
| Volatile matter | 1.35 |
| Water | .21 |
| Ash | 7.75 |
| Sulphur | .67 |
| Total | 100.00 |

Mr. Farrell also gives the following comparison, taken from the records of the Lynchburg Iron Company, of the work performed by Pocahontas and Connellsville cokes in the Lynchburg furnace:

*Working of furnace on all Pocahontas coke from September 18, 1884, to December 31, 1885.*

| | Tons. |
|---|---|
| Coke used per ton of iron made | 1.49 |
| Ores used per ton of iron made | 2.02 |
| Limestone used per ton of iron made | .88 |

*Working of furnace on all Connellsville coke from September 5, 1885, to December 31, 1885.*

| | Tons. |
|---|---|
| Coke used per ton of iron made | 1.50 |
| Ores used per ton of iron made | 2.01 |
| Limestone used per ton of iron made | 1.03 |

The average daily yield of iron, including time of blowing in, stops, etc., was 40.8 long tons. Mr. Farrell, as the result of this comparison, gives it as his opinion, "that the coke produced in Virginia from Pocahontas and Flat Top coals is fully equal to Connellsville, at least so far as furnaces of moderate height are concerned."

## WASHINGTON.

The only coke works on the Pacific coast, so far as has been ascertained, is that of the Tacoma Coal Company, at Wilkeson, Pierce county, Washington Territory. The coal and the coke made from this establishment were described in the last volume of the "Mineral Resources." In 1884 only pits were used; most of the coke made in the present year has also been made in pits. Two ovens, however, have been built and operated for a short time. The coke is used at various places on the

Pacific coast from San Francisco northwardly, with as good satisfaction, it is claimed, as the English and Welsh cokes. The company propose to erect twenty-five or more beehive ovens during 1886.

The report received contained no statement as to the value of the coke. The price in 1884, $4.75 per ton, has been assumed.

The following are the statistics of the manufacture of coke in Washington Territory for the years 1884 and 1885, the only years in which coke has been made:

*Statistics of the production of coke in Washington Territory in* 1884 *and* 1885.

| | 1884. | 1885. |
|---|---|---|
| Number of establishments | 1 | 1 |
| Number of ovens built | 0 | 2 |
| Number of ovens building | 0 | 0 |
| Coal used in the production of coke, short tons | 700 | 544 |
| Coke produced, short tons | 400 | 311 |
| Total value of coke at ovens | $1,900 | $1,477 |
| Value of coke at ovens, per ton | $4.75 | $4.75 |
| Yield of coal in coke, per cent | 57½ | 57 |

Pits were used entirely in 1884, and in part in 1885.

## WEST VIRGINIA.

The localities in which coke is made in West Virginia may for convenience be divided into three districts, the Kanawha, the New River, and the Northern. The first two are compact and continuous. They include the ovens along the line of the Chesapeake and Ohio railroad, from Low Moor, in Virginia, to the Kanawha valley. The Low Moor ovens, though located in Virginia, are included among those of West Virginia, for the reason that all the coal used in them is from mines in West Virginia. The division between the two districts, the New River and Kanawha, is at Hawk's Nest, and is based, in part, upon locality and in part upon the coal used, the New River coals being No. XII. of Rogers's classification, the Kanawha coals No. XIII.

The third district, the Northern, is a scattered one, including the ovens in Preston, Taylor, Harrison, and Marion counties, and those at Wheeling, in Ohio county.

*Total coke production in West Virginia.*—Consolidating the statistics of the different districts given below, the following are the statistics of the production of coke in West Virginia from 1880 to 1885:

*Statistics of the manufacture of coke in West Virginia,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 18 | 19 | 22 | 24 | 27 | 27 |
| Ovens built | 631 | 689 | 878 | 962 | 1,005 | 978 |
| Ovens building | 40 | 0 | 0 | 0 | 127 | 63 |
| Coal used, short tons | 230,758 | 304,823 | 366,653 | 411,159 | 385,588 | 415,533 |
| Coke produced, short tons | 138,755 | 187,126 | 230,398 | 257,519 | 223,472 | 260,571 |
| Total value of coke at ovens | $318,797 | $429,571 | $520,457 | $563,490 | $425,952 | $485,588 |
| Value of coke at ovens, per ton | $2.30 | $2.30 | $2.26 | $2.19 | $1.91 | $1.86 |
| Yield of coal in coke, per cent | 60 | 61 | 63 | 63 | 62 | 63 |

Though there have been changes in the number of establishments in the several districts, old ones being abandoned and new ones coming into existence, the total number in the State remains the same as at the close of 1884, the changes balancing each other. There has been a slight reduction in the number of ovens reported, but in view of the depressed condition of the iron trade, a gratifying increase in production, over 17 per cent.

The field of coking coals on the Kanawha river, and especially that part of it worked on its branch, the New river, including the coal of the Flat Top region, coked in Virginia, is one of the most important and valuable of the Appalachian basin. The coke made from these coals is a most excellent fuel, and though it has not, as yet, and may not obtain as wide a market as the Connellsville, it will not be because of its inferiority. It contains, as a rule, less ash and is nearly if not quite as strong and vigorous as a furnace fuel. As a rule, the veins of the New river are not as thick, nor as uniform in their thickness, as those of Connellsville, nor as well located for economy of handling between the mine and ovens. It is, however, one of the two most important areas of first-class coking coal in the country.

*The Kanawha district.*—Included in this district are all of the ovens from Ansted down the Kanawha, all drawing their coal from formation No. XIII. of Rogers's classification. These coals were so fully described in the last report as to require but little further statement.

The coke from these coals is used in the blast furnaces of the Ohio River, Hocking Valley (Ohio) and Columbus (Ohio) districts, and is regarded with great favor by the furnace managers in these localities. The Great Kanawha Colliery Company, limited, is building an addition of twenty-one ovens to its plant, and contemplates a greater increase early in 1886. At the Gaymont mines, near Hawk's Nest, a new works with twelve ovens is building, and at the Mount Carbon mines another new establishment with thirty beehive ovens is under construction, to be completed early in 1886.

The following analysis by Prof. W. N. Lord is of a coke made in this district by the Saint Clair Company, near Eagle:

*Analysis of Saint Clair (West Virginia) coke.*

| | Per cent. |
|---|---|
| Carbon | 90.88 |
| Ash | 8.55 |
| Sulphur | .57 |
| Total | 100.00 |

The following are the statistics of the production of coke in the Kanawha, West Virginia, district, for the years 1880 to 1885:

*Statistics of the manufacture of coke in the Kanawha district, West Virginia,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 4 | 4 | 5 | 5 | 6 | 7 |
| Ovens built | 18 | 18 | (*a*) 138 | (*a*) 147 | (*a*) 177 | (*b*) 181 |
| Ovens building | 0 | 0 | 0 | 0 | 15 | 63 |
| Coal used, short tons | 6,789 | 11,516 | 40,782 | 58,735 | 60,281 | 65,348 |
| Coke produced, short tons | 4,300 | 6,900 | 26,170 | 37,970 | 39,000 | 37,551 |
| Total value of coke at ovens | $9,890 | $16,905 | $62,808 | $88,090 | $76,070 | $63,082 |
| Value of coke at ovens, per ton | $2.30 | $2.45 | $2.40 | $2.32 | $1.95 | $1.68 |
| Yield of coal in coke, per cent | 63⅓ | 60 | 64 | 64⅔ | 64⅔ | 57 |

*a* Eighty of these ovens are Coppeé, the balance beehive.
*b* Sixty of these ovens are Coppée, the balance beehive.

During the year there has been a decrease of one in the number of works and an increase of two new establishments, making a total increase of one. At three of the seven works no coke was made in 1885, two being in course of construction and one idle the entire year.

*New River district.*—The New River coking district includes the ovens along the line of the Chesapeake and Ohio railroad from Low Moor, in Virginia, to Nuttall. At Nuttall the coals of the New River, the No. XII. of Rogers, the Pottsville Conglomerate of the Pennsylvania survey, begin to be utilized for coking purposes, and from this point, along the cañon of New river to where the lowest bed of the series goes into the air at Quinnimont, the coals of all three beds of these measures are used for coking, making a coke high in carbon, low in ash, strong and vigorous, and giving the best results as a furnace fuel. Indeed, no better coking coal is found in the whole Appalachian basin from Pennsylvania to Alabama. So much has been written about the coals and cokes of this district as render unnecessary any extended remarks here. In the last volume this district and its cokes were very fully discussed.

The statistics of the manufacture of coke in the New River district of West Virginia from 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in the New River district, West Virginia,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 6 | 6 | 6 | 6 | 8 | 8 |
| Ovens built | 468 | 499 | 518 | 546 | 547 | 519 |
| Ovens building | 40 | 0 | 0 | 0 | 12 | 0 |
| Coal used, short tons | 159,032 | 219,446 | 233,361 | 264,171 | 219,839 | 244,769 |
| Coke produced, short tons | 98,427 | 136,423 | 148,373 | 167,795 | 135,335 | 156,007 |
| Total value of coke at ovens | $239,977 | $334,652 | $352,415 | $384,552 | $274,988 | $325,001 |
| Value of coke at ovens, per ton | $2.44 | $2.45 | $2.38 | $2.29 | $2.03 | $2.08 |
| Yield of coal in coke, per cent | 62 | 62 | 64 | 64 | 62 | 63¾ |

The increase in production during the year has been about 16 per cent. There also has been a slight appreciation in the value of this coke per ton. The record shows a decrease in the number of ovens during the year. The same remarks as to the yield of coal in coke can

be made as were made last year. The yield per ton of coal is 1 per cent. greater this year than last. The range of yield reported is from 60 per cent. to 66⅔ per cent., and the average 63¾ per cent.

All of the ovens in this district are beehive of the ordinary pattern. The charge of coal is 3 tons, the time of coking forty-eight and seventy-two hours. Forty-eight hour coke is generally considered to be worth appreciably less in the manufacture of pig iron than seventy-two hour coke, but Mr. J. H. Skelding, the founder of Low Moor furnace, Alleghany county, Virginia, states to *The Virginias* that after numerous trials he finds he always gets better results from the forty-eight hour coke, made from New River semi-bituminous coal in the ovens at that furnace, than from the seventy-two hour from the same coal and ovens.

*The Northern district.*—In this district are included the ovens in a group of counties lying along the Baltimore and Ohio railroad on the headwaters of the Monongahela river—Preston, Taylor, Harrison, and Marion—and those of Ohio county, in the northern part of the "Pan Handle." The coke made at Wheeling, in Ohio county, is made in small amounts, to supply a local demand from glass works.

As yet coking in this district is carried on in a limited way. But one of the twelve works has over thirty-three ovens, and seven have twenty or less. Though the works are small the industry is a growing one, production of the past year having increased nearly 40 per cent. The number of works in existence has decreased one. Three of the twelve works regarded as in existence during the year, with fifty-four ovens, were idle the entire year, while few of the others were run to their full working capacity.

The statistics of the production of coke in the Northern district of West Virginia for the years from 1880 to 1885 are as follows:

*Statistics of the manufacture of coke in the Northern district, West Virginia,* 1880 *to* 1885.

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Number of establishments | 8 | 9 | 11 | 13 | 13 | 12 |
| Ovens built | 145 | 172 | 222 | 269 | 281 | 278 |
| Ovens building | 0 | 0 | 0 | 0 | 100 | 0 |
| Coal used, short tons | 64,937 | 73,863 | 92,510 | 88,253 | 78,468 | 105,416 |
| Coke produced, short tons | 36,028 | 43,803 | 55 855 | 51,754 | 49,139 | 67,013 |
| Total value of coke at ovens | $68,930 | $78,014 | $105,214 | $90,848 | $74,894 | $97,505 |
| Value of coke at ovens, per ton | $1.91 | $1.78 | $1.88 | $1.76 | $1.52 | $1.45 |
| Yield of coal in coke, per cent | 55 | 59 | 60 | 59 | 63 | 63½ |

*The Bluestone district.*—What has come to be known as the Bluestone district is a portion of the great Flat Top coal field of the Virginias, but is located chiefly, if not entirely, in West Virginia, as the Pocahontas portion of the same field is in Virginia. Indeed, this entire Flat Top coal is but a continuation of the New River coal of West Virginia, the Pocahontas seam in the Flat Top having been correlated with

the Quinnimont seam in the New River series. As yet, there are no ovens in this district, but as some very interesting experiments have been made with the Bluestone coals, and as two hundred ovens are projected for 1886, it becomes of importance to refer to its coals and the cokes made from them.

The coals with which the experiments to be described were made were from Mercer county, West Virginia. The Bluestone Coal Company owns a large tract of these Flat Top coals in this section, but does not itself operate collieries, leasing on royalties to operators. The coal experimented upon was from No. III., or the Pocahontas seam, which, as is stated above, has been identified as the equivalent of the Quinnimont seam in the New River. The coal used for the test, and that at Pocahontas are identical and from the same seam, but a few miles apart, exhibiting precisely the same chemical analysis. The object of the test was to determine whether the modified form of the Belgian coke oven, known as the Soldenhof-Coppée, would yield a coke superior to that now being made in the ordinary "beehive" oven at the works of the Southwest Virginia Improvement Company at Pocahontas, Virginia, from the same coal.

The improvements in the coke sought, and hoped to be obtained, by these ovens, as explained by Mr. J. H. Bramwell, engineer of the Bluestone Coal Company, in a letter to *The Virginias*, were:

"1. A greater degree of hardness, so as to resist the dissolving action of the ascending currents of carbonic acid at too early a period in the reductions of the blast furnace.

"2. Firmness and coherence, to overcome the excessive loss from disintegration in drawing the oven charges and in the subsequent handling and transportation, owing to its unusual tenderness and friability.

"3. Uniformity of structure, to counteract the disposition exhibited by the coals low in volatile matter toward a spongy inflation, particularly the case in burning 48-hour coke where rapid combustion is required to insure coking within the given time; 72-hour coke exhibits this tendency to a very much less extent.

"The Flat Top (Pocahontas) coals lack a sufficiency of bitumen to enable them to agglutinate properly in coking in the 'beehive' oven, and when the charge is drawn a considerable proportion of coke is found to break into fragments too small for shipment, and consequently a total loss, materially decreasing the percentage of yield. Evidences of a more than ordinary disposition to disintegrate and crumble can be seen in the accumulation of fine coke and braze both on the coke yards and in the furnace stock houses.

"Another difficulty is experienced in maintaining hot ovens, as it frequently requires a sacrifice of fixed carbon in the coals that are being coked to restore the heat requisite to hold the ovens at a proper cok-

ing temperature. Furthermore, in quenching an oven, preparatory to drawing, great care must be exercised or 'cold bottoms' and 'black ends' ('nigger head') coke will result, and for the several succeeding charges careful attention will be necessary to bring the ovens up to a proper working heat.

"As we cannot change the nature of our Flat Top coals, and as it is altogether unlikely that we can secure a more desirable coking coal, therefore it becomes a necessity—if after two years' trial with 'beehive' ovens we have failed to obtain as satisfactory results as are desired—to try other methods of coking than the one that has been tried and that has been found peculiarly adapted to coals possessing high coking attributes but differing greatly in composition and character from these Flat Top coals. As the Soldenhof-Coppée and other ovens of Belgian type have succeeded elsewhere in yielding results highly satisfactory with coals of a constitution resembling the Flat Top coals, it seemed quite possible that we might also succeed; but to what extent and in what particular direction our efforts should be specially prosecuted only practical experiments can determine.

"To learn how to improve the quality and to lessen the cost of production of our coke, that we may eventually extend our trade in it beyond the consuming points not absolutely dependent upon its district, were the objects specially had in view in undertaking the experiments in the ovens at Hawk's Nest. The results of these experiments, as given below, I think highly gratifying; in my opinion they conclusively demonstrate the superiority of the Soldenhof-Coppée ovens for coking the dry, low-volatile-matter coals of the Flat Top field over the beehive ovens.

"It is not claimed that we have as yet succeeded in realizing the highest attainable results, but that we have ascertained certain facts which, with further experiences and experiments will undoubtedly lead to the introduction of a system of coking in a class of ovens better adapted to these coals than are the ordinary beehive ovens.

"It does not follow because a given coal will not yield a good coke in a beehive oven that it is not a good coking coal, for if it did many of our iron industries would have to depend on coal fields too remote for consideration and quietly succumb for want of good fuel. The proper policy to adopt is that of intelligence, practical experiment, and inquiry, similar to that of the German, French, and Belgian coke makers and iron masters who sought relief from their difficulties with inferior coking coals through improved coking processes rather than in vainly seeking that which nature had failed to provide, that is a coal that would coke well in a beehive oven. The results of their efforts are seen in the huge and successful industrial establishments of John Cockerill, at Seraing, in Belgium; of the Krupps, at Essen, in Germany; and those of Creusot, Terrenoire, and St. Etienne, in France.

"The coal used in the test was two weeks on its way to the ovens. The exposure during this interval of two weeks undoubtedly diminished to some extent the coking power of this coal. The coal was shipped in the following kinds and proportions, from the three collieries now operated by lessees of the Bluestone Coal Company:

| | Slack. | Run of mine. | Total. |
|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Pounds.* |
| John Cooper & Co | 42,900 | ..... | 42,900 |
| Freeman & Jones | 43,250 | 46,850 | 90,100 |
| William Booth & Co | 42,650 | ..... | 42,650 |
| Total pounds shipped | ..... | ..... | 175,650 |

"As the best results from any coking process can be best secured from material in a uniform physical condition, these coals passed through a crusher previous to being charged into the Soldenhoff-Coppée ovens. This reduction to a uniform degree of fineness is a more important factor than is generally supposed, as it is evident that the greater surface exposure of fine coal will cause it to evolve its volatile constituents more quickly and to coke more rapidly than the lumps of coal, if any be present. The quality of coke made from coal previously crushed appears to be more regular and compact than that made from uncrushed coal.

"*Tests, giving the charges, the time of discharging the ovens, the percentages of yield, etc.*

| | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. |
|---|---|---|---|---|---|
| Number of ovens charged | 6 | 4 | 4 | 6 | 9 |
| Tons charged in each oven | 3 | 2.5 | 2.5 | 2.75 | 2.5 |
| Total tons charged in test | 18 | 10 | 10 | 16.5 | 2.5 |
| Time of coking, hours | 36 | 24 | 30 | 48 | 36 |

| | |
|---|---|
| Total yield of coke from all tests, tons | 51.54 |
| Average percentage of coke per ton of coal coked | 67.5 |

"No. 1 test, made July 9, produced a coke not sufficiently coked through to the center; the charge was pushed out with difficulty.

"No. 2 test, made July 10, gave a coke apparently well coked, but dull in color.

"No. 3 test, made July 10, yielded a coke very uniformly coked, and bright and compact.

"No. 4 test, made July 11, furnished a bright, compact coke, but there was considerable ash left at the doors of the ovens.

"No. 5 test, made July 12, furnished a coke bright, regular, and uniform throughout."

Samples of the coke so made were submitted to Mr. A. S. McCreath, chemist of the Second Geological Survey of Pennsylvania, for analysis, and to Mr. John Fulton, general mining engineer of the Cambria Iron Company, for physical tests. The results of these investigations were

communicated to Mr. F. J. Kimball, president of the Norfolk and Western railroad, and by him furnished *The Virginias*, as follows:

Mr. McCreath reports: "The sample of Flat Top coke received from you July 27 yields on analysis the following results:

| | Per cent. |
|---|---|
| Fixed carbon | 91.110 |
| Moisture at 212° F. | .542 |
| Ash | 7.021 |
| Sulphur | .839 |
| Volatile matter | .488 |
| | 100.000 |
| Phosphorus | .006 |

"An average sample was submitted to Mr. John Fulton for his report on its physical properties as compared with the standard Connellsville coke. His report in full is herewith submitted. It shows that while the Flat Top coke is inferior to Connellsville in hardness and cell development its burden bearing strength is much greater, the ratio being 114 to 134. Chemically considered, the Flat Top coke is much superior to the Connellsville, showing, as it does, fully 4 per cent. less ash and over 3 per cent. more fixed carbon, while the phosphorus is very much lower. Mr. Fulton's report is so complete that I submit it without further comment."

Mr. Fulton's report is accompanied by the following table, exhibiting the physical and chemical properties of Connellsville standard coke and this Flat Top coke in comparison, from Mr. Fulton's own tests and Mr. McCreath's analyses:

| | Connellsville. | Flat Top. |
|---|---|---|
| Grams in 1 cubic inch: | | |
| Dry | 12.46 | 15.30 |
| Wet | 20.25 | 23.39 |
| Pounds in 1 cubic foot: | | |
| Dry | 47.47 | 58.31 |
| Wet | 77.15 | 89.12 |
| Percentage of: | | |
| Coke | 61.53 | 65.42 |
| Cells | 38.47 | 34.58 |
| Compressive strength per cubic inch, one-fourth ultimate strength | 284 | 335 |
| Height of furnace charge supported without crushing | 114 | 134 |
| Order in cellular space | 1 | 1.25 |
| Hardness | 3.5 | 2.8 |
| Specific gravity | 1.50 | 1.73 |
| Fixed carbon | 87.46 | 91.11 |
| Moisture | .49 | .54 |
| Ash | 11.32 | 7.02 |
| Sulphur | .69 | .84 |
| Phosphorus | .029 | .006 |
| Volatile matter | .011 | .488 |

Mr. Fulton, under date of August 1, 1885, reports as follows to Mr. McCreath: "As you requested, I have carefully examined the physical properties of the sample of coke you forwarded July 27. The coke is reported to have been made from unwashed slack coal. The coal came

from the Flat Top region of Virginia, and was coked in Coppée's coke ovens, thirty six hours' coke, at Hawk's Nest, New river, Virginia. The chemical analysis shows a coke low in ash, sulphur, and phosphorus, and consequently high in fixed carbon. So far as these determinations show it is cleaner fuel than the standard Connellsville. The number of little disks of slate in this coke would lead an observer to expect more ash. The Tioga, Pennsylvania, coke is similarly marked, holding considerable ash. The coke has a dull color, and is much softer than the standard. The volatile matter, 0.488 per cent., indicates a want of heat in the oven or time to complete coking. The physical structure of this coke is dense, not hard; while the ratio of cells and pores to body of coke indicates this, there is an evident repression of cell development in the operation of coking. The compressive or burden-bearing strength of this coke is quite high. Three cubes were broken in a Gill testing machine, and the average result is given in the table. There is a toughness in this coke which is not found in the standard or similar hard-bodied samples. The softness of this coke is the principal deficiency for use in blast furnaces. It has been shown that soft coke, in smelting iron, is more easily attacked by carbonic acid than hard coke. That is, soft coke is set on fire by the ascending carbonic acid gas high up in the furnace; its destruction above the zone of its real work is not only of no value, but it disarranges the regular operations of the furnace. I would hesitate to assure the success of this quality of coke in competition with other cokes in this section of Virginia which I have examined, especially the Fire Creek and Pocahontas. Practically, the inquiry arises here, How can this coal be coked to insure a hard-bodied fuel, with well developed cells? A test in a hot beehive oven should be made before final conclusions are accepted. Should such a test not produce better results in the coke it would become a serious question whether some more desirable coking coal should be secured. The broad principle has been laid down that the coal determines the quality of the coke, not the special kind of oven. Hence the first requirement is a known good quality of coking coal. The Coppée is one of a large family of Belgian ovens. It was especially designed to coke a soft, friable, inferior coking coal. It differs slightly from the other members of this family in the arrangement of its flues. It, in common with the whole class of such ovens, retains heat, and can coke coal low in hydrogenous matter. It produces a larger percentage of coke than the beehive family, but the product is much denser and usually softer than the product of the latter class of ovens.

"The whole range of coke ovens comes under two distinct classes: Those heated internally, the beehives, and those heated externally, the Belgians. The former class produce the best metallurgical coke, but are somewhat wasteful and less economic in operation. The latter afford a larger yield of coke at a reduced cost of operating, but the original cost of these ovens is double that of the beehives, and the coke

inferior in hardness and cell development. Sir I. L. Bell has proved in a paper read before the London meeting of the Iron and Steel Institute, published in the *Iron Age* of May 28 last, that 22½ cwt. of coke made in beehive ovens was equal to 25 cwt. of Simon-Carves oven-made coke, both cokes from coal taken from the same coal bed. 'In other words, the extra yield of coke (in Simon-Carves ovens) will bring little profit to the coke burner.' These results are controverted by some, but the great principles that govern the furnace coke makers are unchanged: that all coking operations should be directed to produce a hard-bodied cellular coke. Aside from the economy of the percentage of coke produced, there is no discussion that the beehive or internally heated ovens produce the best metallurgical coke. The narrow-chambered Belgian oven family, of whatever name, compress the fusing mass of coke and make dense coke. Now, the most dense furnace fuel known is anthracite coal—a natural coke. But the yield of an anthracite furnace is, say, 500 tons of pig iron per week, while a coke furnace will produce 700 or 800 tons of pig metal in the same time. Why should coke makers endeavor to imitate this slow furnace fuel? Anthracite furnacemen are rapidly increasing the use of coke in their furnaces. The Tioga coke ovens, using a dry coal, found it a decided improvement to construct double floors of brick in their beehive ovens, so as to secure a 'store of heat.' This, with the improved beehive door, increases the hardness of body of coke and yield in the beehive ovens."

# PETROLEUM.

By S. H. Stowell.

Petroleum has been known to exist in this country almost from its first settlement. The records of travels, especially through the region west of the Appalachian chain, in what was then known as the Great Ohio Valley, contain constant evidences of the existence of this material in the reports of burning springs and the oil that accompanied them.

It was not, however, until 1859, at the time of the drilling of Drake's first well, that it began to assume any commercial importance. The excitement attending the discoveries in the Pennsylvania oil field led to explorations in many States, and developed the fact that petroleum existed in many localities. These localities are chiefly on the western slopes of the Appalachian chain, reaching from Petrolea in Ontario to just across the Tennessee State line in Alabama. Some quite extensive fields are also found in California and in Wyoming, and later evidences of the existence of oil have been discovered in other States, but the Appalachian and the California oil fields are at present the only ones of commercial importance.

The most important of these fields are what are described further on as the Pennsylvania and New York oil fields. Next in importance to these is the Macksburg field in Ohio, near Marietta, the third in importance being the California field. West Virginia produces some small amounts of heavy oil for lubricating purposes, its light oil having been comparatively exhausted some years since. There are also oil fields that with better facilities for transportation might be of importance in both Tennessee and Kentucky. The Wyoming oil fields described further on in this report are also of importance in the amount of petroleum that can some day be made available, but of this field, as of all others outside of the Pennsylvania and Macksburg regions, with the exception of California, it will be found that the expense of producing and transporting the oil to market will effectually prevent any great production in these fields until the price of Pennsylvania petroleum shall materially advance. Full descriptions of these fields will be found either in the subsequent pages of this report or in the previous volumes of "Mineral Resources."

In the following table will be found a consolidation of the statistics of the production of petroleum in the various fields of the country and

Canada, so far as the same could be obtained from the beginning of operations in these fields:

*Production of crude petroleum in the United States and Canada from* 1859 *to* 1885, *inclusive.*

| Years. | Pennsylvania and New York. | West Virginia. | Ohio. | Kentucky and Tennessee. | California. | Canada. (*a*) |
|---|---|---|---|---|---|---|
| | *Barrels.* (*b*) | *Barrels.* | *Barrels.* | *Barrels.* | *Barrels.* | *Barrels.* |
| 1859 | 2,000 | | | | | |
| 1860 | 500,000 | | | | | |
| 1861 | 2,113,600 | | | | | |
| 1862 (*c*) | 3,056,690 | | | | | 11,775 |
| 1863 | 2,611,300 | | | | | 82,814 |
| 1864 | 2,116,109 | | | | | 90,000 |
| 1865 | 2,497,700 | | | | | 110,000 |
| 1866 | 3,597,700 | | | | | 175,000 |
| 1867 | 3,347,300 | | | | | 190,000 |
| 1868 | 3,646,117 | | | | | 200,000 |
| 1869 | 4,215,000 | | | | | 220,000 |
| 1870 | 5,260,745 | | | | | 250,000 |
| 1871 | 5,205,341 | | | | | 269,397 |
| 1872 | 5,939,003 | | | | | 308,100 |
| 1873 | 9,890,964 | | | | | 365,052 |
| 1874 | 10,950,730 | | | | | 168,807 |
| 1875 | 8,787,506 | (*d*) 3,000,000 | (*d*) 200,000 | | (*d*) 175,000 | 220,000 |
| 1876 | 8,968,906 | 120,000 | 31,763 | | 12,000 | 312,000 |
| 1877 | 13,135,671 | 172,000 | 29,888 | | 13,000 | 312,000 |
| 1878 | 15,165,462 | 180,000 | 38,179 | | 15,227 | 312,000 |
| 1879 | 19,741,661 | 180,000 | 29,112 | | 19,858 | 575,000 |
| 1880 | 26,032,421 | 179,000 | 38,940 | | 40,552 | 350,000 |
| 1881 | 27,358,210 | 151,000 | 33,867 | | 99,862 | 275,000 |
| 1882 | 30,053,500 | 128,000 | 39,761 | | 128,636 | 275,000 |
| 1883 | 23,128,389 | 126,000 | 47,632 | | 142,857 | 250,000 |
| 1884 | 23,772,209 | 90,000 | 90,081 | | 262,000 | 250,000 |
| 1885 | 20,776,041 | 91,000 | 650,000 | | 325,000 | 250,000 |
| Total | 281,870,293 | 4,417,000 | 1,229,223 | 175,000 | 1,233,992 | 5,821,945 |

*a* There are no reliable statistics of production for Canada. Those given are the estimates of parties intimately connected with the industry.
*b* All barrels in this table are of 42 gallons.
*c* In addition to the above it is estimated that for want of a market some 10,000,000 barrels ran to waste in and prior to 1862 from the Pennsylvania and Canada fields; also a large amount from West Virginia and Tennessee.
*d* Including all production prior to 1876.

Outside of the Pennsylvania oil fields the above production is made up from data which are only complete enough to present as an approximation. The same may be said of the Pennsylvania oil fields for the first four or five years; since that time a very satisfactory record has been preserved.

## PENNSYLVANIA AND NEW YORK.

Owing to their intimate connection in a commercial way, it is almost impossible to make an exact separation between the oil produced in New York and that from the wells of Pennsylvania. In the early history of the northern district no such separation was attempted. Almost from the first the Bradford district included some wells in New York, but this was all run into Pennsylvania and distributed through the distributing agencies of that State. The amount was small, however, and, commercially, no account was taken of the State in which the oil was produced. Latterly, however, the Allegany field has been regarded as a district by itself. To the oil that is reported in such a way as to make it beyond question that it is from New York is added an

estimate of that about which there is some doubt, and the reports of the Allegany field may be regarded as including all the oil produced in New York.

So far as any division is made of the Pennsylvania and New York oil fields, four districts are given in this report: (1) Allegany or Richburg, (2) Bradford, (3) Warren and Forest, and (4) Lower.

These districts were fully described in the report for 1883–'84. It may be well, however, to say that the Allegany field lies wholly in Allegany county, New York, and is of irregular shape, with an average length of some 20 miles. Outlying this district in the same county are three smaller fields, of which one, about a mile from the town of Niles, and bearing its name, is the farthest north of any development. The Wirt field, midway between Niles and the main field, is larger, but produces more gas than oil.

The Bradford district lies chiefly in Pennsylvania, in the county of McKean, but the main field extends at least 5 miles into the State of New York, and an outlying basin of oil rocks, which properly belongs to the Bradford basin, is contained for the greater part in Carrollton township, in Cattaraugus county, New York.

The Middle oil field—the Warren and Forest—is located in the two counties from which it takes its name. It includes the three white-sand pools of Cherry Grove, Balltown, and Cooper; the close-pebble district of Stoneham, Clarendon, and Tiona, together with Kinzua, and the recently developed field of Kane and the older pool at Grand Valley.

The Lower field begins with a few pools in the southwestern corner of Warren and the western end of Forest counties, and embraces all of the oil-producing territory to the southward, including the fields in Venango, Clarion, and Butler, with its Thorn Creek pool; the field on the Ohio river, in Beaver county; the Slippery Rock field, along Slippery Rock creek in Lawrence county; the Pleasant Unity field, in Westmoreland county; the deposits in Greene county; the Shousetown, in Allegheny; the Washington, the Mount Nebo, and other smaller fields. The statistics of production given under the head of the oil fields of Pennsylvania and New York include all of the crude from these several districts.

More than 50 per cent. of all the oil produced in the United States is from the Bradford and Allegany fields, these two districts being credited with 11,099,512 of the 21,842,041 barrels produced in the country in 1885. The production in these fields, however, is kept up only by the liberal use of nitro-glycerine, and even with the use of explosives to an extent before unknown the production is falling off, and it is a question if the vigor of these old fields can be restored.

The interest in the drilling operations in the territory included in the Pennsylvania and New York district in 1885 began in the Washington section with the Gantz well. The results following the opening of this well were not encouraging, but later in the year a new productive hori-

zon at some depth below the formation in which the Gantz well occurred revived the interest in this field, indicating a producing district that will prove of some importance during the year 1886. The total production of Washington county in 1885 was some 10,500 barrels.

During the early part of 1885 the Thorn Creek subdistrict in Butler county attracted considerable attention. The highest development in this field in 1885 was in April. On the 11th of that month 89 wells were producing some 12,290 barrels of oil; on July 18, 156 wells were producing but 2,956 barrels, and on August 22 the number of wells had increased to 157, but the production had dropped to 2,174 barrels. An evidence of the great decline in this district is seen in the fact that in November, 1884, with but 18 wells, one day's production was 15,445 barrels.

Cogley run, in Clarion county, assumed considerable importance in 1885. The initial well was tubed January 8, and its first two weeks' production was but 150 barrels. A pool some 5 miles in length has been developed since this first well, and the production credited to Cogley run in 1885 was over 700,000 barrels.

The Clarendon district, in Warren county, has been greatly enlarged on all sides during the past year. The wells are small, but their aggregate production reaches a considerable figure. Kinzua village has produced several gushers in the past twelve months. The Kane well furnished the pretext for a heavy "bear" movement, but the indications at the close of the year in this field were not very flattering.

*Production.*—In the following table is given a statement of the production of the Pennsylvania and New York oil fields during the year 1885, by months and districts. As is stated elsewhere, it is well nigh impossible to give the exact proportion of this production that should be credited to Pennsylvania and New York respectively. The production of the Allegany district is, to a near approximation, that of New York. The remainder is the production of Pennsylvania.

*Total production of crude petroleum in the Pennsylvania and New York oil fields for the year 1885, by districts and months.*

| Months. | Allegany district. | Bradford district. | Warren district. | Lower district. | Total. |
|---|---|---|---|---|---|
| | *Barrels.* | *Barrels.* | *Barrels.* | *Barrels.* | *Barrels.* |
| January | 217,744 | 719,758 | 183,086 | 531,588 | 1,652,176 |
| February | 182,672 | 622,104 | 152,964 | 480,144 | 1,437,884 |
| March | 213,776 | 700,290 | 180,885 | 543,182 | 1,638,133 |
| April | 221,880 | 707,700 | 205,050 | 645,660 | 1,780,290 |
| May | 229,276 | 731,290 | 211,885 | 598,920 | 1,771,371 |
| June | 235,170 | 720,930 | 218,280 | 592,830 | 1,767,210 |
| July | 230,454 | 732,406 | 213,001 | 599,943 | 1,775,804 |
| August | 224,254 | 701,406 | 203,701 | 576,600 | 1,705,961 |
| September | 224,520 | 686,280 | 212,130 | 589,860 | 1,712,790 |
| October | 237,460 | 709,497 | 222,580 | 704,568 | 1,874,105 |
| November | 212,490 | 686,610 | 198,090 | 664,470 | 1,761,660 |
| December | 228,315 | 723,230 | 228,966 | 718,146 | 1,898,657 |
| Total | 2,658,011 | 8,441,501 | 2,430,618 | 7,245,911 | 20,776,041 |

Assuming that the production of the Allegany district represents that of New York State, the production of crude petroleum in New York in 1885 would be 2,658,011 barrels, and that of Pennsylvania in the same year 18,118,030 barrels. The production of each State on the basis assumed for the past four years is as follows:

| Years. | Pennsylvania. | New York. |
|---|---|---|
| | *Barrels.* | *Barrels.* |
| 1882 | 23, 367, 769 | 6, 685, 731 |
| 1883 | 19, 124, 799 | 4, 003, 590 |
| 1884 | 21, 540, 852 | 3, 231, 357 |
| 1885 | 18, 118, 030 | 2, 658, 011 |

This table indicates the great falling off in the production of the New York field in the four years for which totals are given, the decline being from six and two-third millions barrels in 1882 to two and two-third millions barrels in 1885. There has also been a marked decline, some 5,000,000 barrels, in the production of the Pennsylvania field in the same period, but the percentage decline is not so great as in New York.

The following table gives the total production of the Pennsylvania and New York oil fields for each year since 1859. There is a difficulty in ascertaining just what proportion of these two States should be credited to each. The collections and deliveries of the pipe lines are so arranged that the best that can be done is to make an estimate. The facts upon which to base this estimate, however, are so many and so complete as to justify the belief that the estimate is a very close one.

*Total production of crude petroleum in the Pennsylvania and New York oil fields for the years from* 1859 *to* 1885, *inclusive.*

| Years. | Production. | Years. | Production. |
|---|---|---|---|
| | *Barrels.* | | *Barrels.* |
| 1859 | 2, 000 | 1873 | 9, 890, 964 |
| 1860 | 500, 000 | 1874 | 10, 950, 730 |
| 1861 | 2, 113, 699 | 1875 | 8, 787, 506 |
| 1862 | 3, 056, 690 | 1876 | 8, 968, 906 |
| 1863 | 2, 611, 309 | 1877 | 13, 135, 671 |
| 1864 | 2, 116, 109 | 1878 | 15, 165, 462 |
| 1865 | 2, 497, 700 | 1879 | 19, 741, 661 |
| 1866 | 3, 597, 700 | 1880 | 26, 032, 421 |
| 1867 | 3, 347, 300 | 1881 | 27, 358, 210 |
| 1868 | 3. 645, 117 | 1882 | 30, 053, 500 |
| 1869 | 4, 215, 000 | 1883 | 23. 128, 389 |
| 1870 | 5, 260, 745 | 1884 | 23, 772, 209 |
| 1871 | 5, 205, 341 | 1885 | 20, 776, 041 |
| 1872 | 5, 939, 003 | | |

The maximum of production was reached, it will be observed, in 1882. This was a most phenomenal year in the history of petroleum production. It was the year of the development of the Cherry Grove field, by the opening of which the average daily production was increased in July, 1882, to 105,102 barrels, the largest ever reached. In this month this field yielded above 30,000 barrels daily, at the close of the year the yield of Cherry Grove was less than 4,000, and the total average daily

yield had fallen from 105,120 barrels in July to 61,210 barrels. The production of 1885 was some 9,300,000 barrels less than in 1882, but it is still in excess of any year prior to 1880.

During 1885 the average daily production of all wells in this district, by months, was as follows:

*Average daily production of wells in the Pennsylvania and New York oil fields in* 1885.

| Months. | Average daily product. | Months. | Average daily product. |
|---|---|---|---|
| | *Barrels.* | | *Barrels.* |
| January | 53,296 | August | 55,031 |
| February | 51,353 | September | 57,093 |
| March | 52,843 | October | 60,455 |
| April | 59,343 | November | 58,722 |
| May | 59,141 | December | 61,247 |
| June | 58,907 | | |
| July | 57,284 | Average | 56,921 |

This average for the year of 56,921 barrels is not the average of the averages, but is obtained by dividing the total products of the year by 365, the number of days in the year.

It will be noted that the average daily production at the close of the year is considerably less than the average of 1884, but in excess of the average for December of that year. The year's average daily product was 56,921 barrels in 1885; the average for December, 1885, 61,247, or 4,326 barrels in excess of the average. The average daily production for December, 1884, was 58,794 barrels.

The average daily production for each month since 1872 and the daily average for the entire year are given farther on.

*Shipments.*—The following table shows the number of barrels of crude petroleum, and of refined petroleum reduced to crude equivalent, shipped out of the Pennsylvania and New York oil regions in 1885. A considerable portion of this is shipped as refined oil. This is reduced to its equivalent in crude, a barrel of refined being regarded as $1\frac{1}{3}$ barrels of crude.

*Shipments of crude petroleum, and of refined petroleum reduced to crude equivalent, out of the Pennsylvania and New York oil regions for the year* 1885.

| Months. | Total shipments. | Months. | Total shipments. |
|---|---|---|---|
| | *Barrels.* | | *Barrels.* |
| January | 1,804,028 | August | 2,049,099 |
| February | 1,895,021 | September | 2,116,659 |
| March | 1,887,034 | October | 2,050,150 |
| April | 1,823,726 | November | 1,857,080 |
| May | 2,097,099 | December | 2,138,253 |
| June | 2,034,025 | | |
| July | 1,951,152 | Total | 23,713,326 |

The shipments out of this region during the past year were but little in excess of those of 1884—less than 60,000 barrels. The reduction in

stocks, noted elsewhere, therefore, is not due to increased shipment, but to a decreased production.

The total shipments from this region for each year since 1866 are as follows:

*Shipments of crude petroleum, and of refined reduced to crude equivalent, from the Pennsylvania and New York oil regions, 1866 to 1885, inclusive.*

| Years. | Shipments. | Years. | Shipments. |
|---|---|---|---|
| | *Barrels.* | | *Barrels.* |
| 1866 | 2,986,667 | 1876 | 10,164,452 |
| 1867 | 3,166,257 | 1877 | 12,832,573 |
| 1868 | 4,039,541 | 1878 | 13,676,000 |
| 1869 | 4,207,548 | 1879 | 15,886,470 |
| 1870 | 5,235,931 | 1880 | 15,677,492 |
| 1871 | 5,664,791 | 1881 | 20,284,235 |
| 1872 | 5,899,947 | 1882 | 21,900,314 |
| 1873 | 9,499,775 | 1883 | 21,979,369 |
| 1874 | 8,821,500 | 1884 | 23,657,597 |
| 1875 | 8,942,938 | 1885 | 23,713,326 |

It will be noted that the shipments out of the Pennsylvania and New York oil fields in 1885 are greater than during any preceding year, being 23,713,326 barrels, as before stated, about 60,000 barrels in excess of the shipments of 1884, which were the next largest. Indeed, it will be seen by inspecting the table that, without reference to the production, there has been a continuous increase year by year in the shipments, with the single exception of 1880, the shipments for 1880 being some 200,000 barrels less than in 1879.

*Stocks.*—In the following table will be found a statement of the total stocks held by all the pipe lines in the Pennsylvania and New York oil regions at the close of each month during 1885:

*Stock of crude petroleum in the Pennsylvania and New York oil regions at the close of each month of the year 1885.*

| Years. | Stocks. | Years. | Stocks. |
|---|---|---|---|
| | *Barrels.* | | *Barrels.* |
| January | 37,214,274 | July | 35,686,909 |
| February | 36,757,137 | August | 35,343,771 |
| March | 36,508,236 | September | 34,939,902 |
| April | 36,464,800 | October | 34,763 857 |
| May | 36,139,072 | November | 34,668,437 |
| June | 35,872,257 | December | 34,428,841 |

An inspection of this table shows that there has been a gradual reduction of stocks during the entire year, the close of each month showing less stock on hand than the close of the preceding month. As the stock December 31, 1884, was 37,366,126 barrels, and that December 31, 1885, 34,428,841 barrels, the reduction in stocks during the year 1885 was 2,937,285 barrels. This was 58,883 barrels less than the decrease in production of 1885, which decrease was 2,996,168 barrels. The exports during 1885 were more than this amount in excess of those of 1884, but the home trade was less.

In the following table will be found a statement of the total stocks held n the Pennsylvania and New York oil regions at the close of each year since 1867, the year of the building of the first iron tank :

*Total stocks of crude petroleum held in the Pennsylvania and New York oil fields at the close of each year from 1867 to 1885, inclusive.*

| Years. | Stocks December 31. | Years. | Stocks December 31. |
|---|---|---|---|
| | *Barrels.* | | *Barrels.* |
| 1867 | 289,100 | 1877 | 3,127,837 |
| 1868 | 559,100 | 1878 | 4,615,299 |
| 1869 | 264,805 | 1879 | 8,470,490 |
| 1870 | 340,154 | 1880 | 18,928,430 |
| 1871 | 537,751 | 1881 | 26,019,704 |
| 1872 | 1,084,423 | 1882 | 34,596,612 |
| 1873 | 1,625,157 | 1883 | 35,745,632 |
| 1874 | 3,705,639 | 1884 | 37,366,126 |
| 1875 | 3,550,207 | 1885 | 34,428,841 |
| 1876 | 2,551,199 | | |

For the first time since 1876 the stocks in this district at the close of the year show a reduction, the stocks at the close of 1885 being 34,428,841 barrels, some 3,000,000 less than at the close of 1884 and 1,300,000 less than at the close of 1883.

*Prices.*—The following table gives the monthly average price of pipe-line certificates for each month during 1885 :

*Average price of pipe-line certificates in 1885.*

| Months. | Average price pipe-line certificate. | Months. | Average price pipe-line certificate. |
|---|---|---|---|
| | *Per barrel.* | | *Per barrel.* |
| January | $0.70⅞ | August | $1.00½ |
| February | .72⅜ | September | 1.00¾ |
| March | .80½ | October | 1.05½ |
| April | .78½ | November | 1.04⅜ |
| May | .79 | December | .89⅞ |
| June | .82 | | |
| July | .92½ | Average | .87⅛ |

These averages, it is understood, are not true average prices, that is, averages that consider both price, and quality sold at that price, but are the averages of the prices obtained. This is the only average that can be obtained, and does not vary greatly from the true average price.

The lowest point touched by pipe-line certificates during the year was January 29, when they sold at one time during the day for 68¼ cents. The highest price was $1.12⅜, on October 20. The price December 31, 1885, was $0.87⅛ and $0.88⅜.

Both the range and the average of prices during 1885 were in excess of those of 1884, the highest average of 1884 being $1.04⅜ per barrel, in February, and the lowest average $0.63½, in July. The highest average in 1885 was $1.05½, in October, the lowest $0.70⅞, in January. The average for 1884 was 83½ cents per barrel. In 1885 it was $0.87⅛, or 4⅜ cents in excess of that of 1884.

The year has entirely baffled the expectations and predictions of many. It was believed that it would show a range of prices much lower than the preceding year. This expectation was not realized. There was a reduction of production, and even the figure attained was only possible through the most strenuous exertions—only by prosecuting field work in all locations, promising or unpromising, with a vigor seldom known in the history of the petroleum trade. As is also shown in connection with the statement concerning stocks, the average production has not been sufficient to supply the consumption demand, and considerable oil was drawn from the reserve supply during 1885. All of these facts would indicate that the price should have advanced even more rapidly than it has done.

The average prices of refined oil per gallon in New York for the months of 1885 were as follows:

| Months. | Prices, in cents, per gallon. | Months. | Prices, in cents, per gallon. |
|---|---|---|---|
| January | 7⅞ | July | 8¼ |
| February | 7⅞ | August | 8⅜ |
| March | 7⅞ | September | 8⅜ |
| April | 7⅞ | October | 8¼ |
| May | 7¾ | November | 8¼ |
| June | 7⅞ | December | 7⅞ |

The average process of pipe-line certificates or crude oil at the wells since 1860 will be given farther on.

*Producing wells.*—The number of producing wells at the close of each month in this district, and the average for the close of each month during the year 1885, is as follows:

*Number of producing wells in the Pennsylvania and New York oil fields at the close of each month in* 1885.

| Months. | Number producing wells. | Months. | Number producing wells. |
|---|---|---|---|
| January | 21,950 | August | 22,688 |
| February | 21,987 | September | 22,775 |
| March | 22,042 | October | 23,062 |
| April | 22,093 | November | 23,295 |
| May | 22,223 | December | 23,519 |
| June | 22,384 | | |
| July | 22,524 | Average | 22,546 |

Compared with the table for previous years given below, and the tables of production, this is a most interesting table. During 1885, as noted elsewhere, there has been a steady decline in production as compared with 1884, amounting during the year to 2,996,168 barrels, and yet the number of producing wells increased each month during the year, the number at the close of 1885 being 23,519, as compared with 21,909 at the close of 1884, an increase of 1,610 during the year. The average number of producing wells at the close of each month in 1885

was 22,546. In 1884 it was 21,526, an increase of 1,020 during 1885. Notwithstanding this the production decreased. The production per well in 1885 and 1884, taking the average daily product and average number of wells producing, was, in 1884, $3\frac{15}{100}$ barrels a day, and in 1885 but $2\frac{57}{100}$. Ten years ago (1875) the average number of producing wells was but 3,098, and the average daily product 24,078 barrels. This was an average daily production per well of about $7\frac{8}{10}$ barrels, more than double what it was in 1884, and three times what it was in 1885.

The following table gives the number of producing wells in this district at the close of each year from 1867, as well as the average number producing at the close of each month during each year:

*Number of producing wells in the Pennsylvania and New York oil fields* 1867 *to* 1885, *inclusive.*

| Years. | Producing wells December 31. | Average number of producing wells at the close of each month. | Years. | Producing wells December 31. | Average number of producing wells at the close of each month. |
|---|---|---|---|---|---|
| 1867 | 1,020 | ..... | 1877 | 8,458 | 7,383 |
| 1868 | 1,246 | ..... | 1878 | 10,337 | 9,561 |
| 1869 | 1,325 | ..... | 1879 | 11,960 | 11,283 |
| 1870 | 2,906 | 2,490 | 1880 | 14,700 | 13,234 |
| 1871 | 3,775 | 3,275 | 1881 | 18,300 | 16,668 |
| 1872 | 4,553 | 4,205 | 1882 | 18,009 | 19,027 |
| 1873 | 3,358 | 4,109 | 1883 | 20,606 | 17,918 |
| 1874 | 3,270 | 3,276 | 1884 | 21,909 | 21,526 |
| 1875 | 3,078 | 3,098 | 1885 | 23,519 | 22,546 |
| 1876 | 6,000 | 4,694 | | | |

*Drilling wells.*—In the following table is given by districts the number of wells drilling at the close of each month in the year 1885, in the Pennsylvania and New York oil fields:

*Number of wells drilling at the close of each month in the year* 1885, *in the Pennsylvania and New York oil fields, by districts.*

| Months. | Allegany district. | Bradford district. | Warren district. | Lower district. | Total. |
|---|---|---|---|---|---|
| January | 7 | 11 | 17 | 62 | 97 |
| February | 11 | 12 | 17 | 69 | 109 |
| March | 10 | 28 | 23 | 78 | 139 |
| April | 22 | 36 | 35 | 97 | 190 |
| May | 28 | 19 | 55 | 126 | 228 |
| June | 31 | 36 | 44 | 98 | 209 |
| July | 41 | 41 | 49 | 111 | 242 |
| August | 58 | 56 | 73 | 121 | 308 |
| September | 45 | 73 | 82 | 182 | 382 |
| October | 53 | 66 | 77 | 159 | 355 |
| November | 70 | 76 | 78 | 135 | 359 |
| December | 30 | 62 | 81 | 104 | 277 |

The same condition exists in regard to drilling wells as is noted elsewhere in connection with wells completed, the close of 1885 showing a largely increased number of wells drilling as compared with 1884, the wells drilling in December, 1885, were also in excess of the number drilling at the beginning of 1884 and very much in excess of the number

drilling at the close of that year. There were drilling in December, 1885, 277 wells as compared with 78 drilling in December, 1884. It can also be remarked that though the average number of wells drilling at the close of each month in 1885 is in excess of the average number drilling at the close of each month in 1884, it is still less than the averages of any year since 1875.

The following table shows the average number of wells drilling during the years since 1871, and also the number drilling in December of each year:

*Number of drilling wells in the Pennsylvania and New York oil fields at the close of December and averages for the years* 1871–'85.

| Years. | December. | Yearly averages. | Years. | December. | Yearly averages. |
|---|---|---|---|---|---|
| 1871 | 394 | 329 | 1879 | 440 | 357 |
| 1872 | 318 | 347 | 1880 | 408 | 495 |
| 1873 | 60 | 242 | 1881 | 468 | 423 |
| 1874 | 54 | 121 | 1882 | 138 | 276 |
| 1875 | 168 | 112 | 1883 | 263 | 243 |
| 1876 | 493 | 363 | 1884 | 78 | 168 |
| 1877 | 426 | 463 | 1885 | 277 | 241 |
| 1878 | 218 | 292 | | | |

*Wells completed.*—In the following table will be found a statement of the number of wells completed in each district in the Pennsylvania and New York oil fields during each month of the year 1885. This statement shows the total number completed, the number producing oil, and the number of dry holes in each district for each month, together with the totals of these several items for the entire year:

*Number of wells completed during each month of the year* 1885 *in the Pennsylvania and New York oil fields, by districts.*

| Months. | Allegany district. | | | Bradford district. | | | Warren district. | | | Lower district. | | | Totals. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number. | Producing. | Dry holes. | Total number. | Producing. | Dry holes. | Total number. | Producing. | Dry holes. | Total number. | Producing. | Dry holes. | Total number. | Producing. | Dry holes. |
| January | 9 | 7 | 2 | 7 | 7 | 0 | 17 | 15 | 2 | 31 | 25 | 6 | 64 | 54 | 10 |
| February | 4 | 2 | 2 | 15 | 14 | 1 | 16 | 15 | 1 | 27 | 24 | 3 | 62 | 55 | 7 |
| March | 5 | 4 | 1 | 14 | 14 | 0 | 24 | 20 | 4 | 39 | 30 | 9 | 82 | 68 | 14 |
| April | 10 | 10 | 0 | 24 | 24 | 0 | 29 | 25 | 4 | 53 | 47 | 6 | 116 | 106 | 10 |
| May | 26 | 23 | 3 | 38 | 35 | 3 | 67 | 60 | 7 | 82 | 72 | 10 | 213 | 190 | 23 |
| June | 33 | 32 | 1 | 40 | 38 | 2 | 66 | 57 | 9 | 103 | 72 | 31 | 242 | 199 | 43 |
| July | 29 | 28 | 1 | 36 | 35 | 1 | 56 | 47 | 9 | 96 | 70 | 26 | 217 | 180 | 37 |
| August | 33 | 31 | 2 | 35 | 35 | 0 | 96 | 87 | 9 | 119 | 91 | 28 | 283 | 244 | 39 |
| September | 60 | 53 | 7 | 67 | 64 | 3 | 82 | 73 | 9 | 147 | 126 | 21 | 356 | 316 | 40 |
| October | 59 | 59 | 0 | 62 | 60 | 2 | 104 | 93 | 11 | 172 | 145 | 27 | 397 | 357 | 40 |
| November | 51 | 47 | 4 | 68 | 65 | 3 | 93 | 83 | 10 | 172 | 135 | 37 | 384 | 330 | 54 |
| December | 54 | 51 | 3 | 62 | 59 | 3 | 95 | 89 | 6 | 134 | 104 | 30 | 345 | 303 | 42 |
| Totals | 373 | 347 | 26 | 468 | 450 | 18 | 745 | 664 | 81 | 1,175 | 941 | 234 | 2,761 | 2,402 | 359 |

While the total number of wells completed during the year 1885, 2,761, is 496 greater than in 1884, it is still less than the total number

completed in any preceding year since 1875. As compared with 1884, however, there is this difference to be noted: there was a decline in the number of wells completed in the previous year as the years drew to a close, there being but 66 wells completed in December, 1884, as compared with 229 completed in January of the same year. The year 1885 shows just the opposite condition of affairs, there being 345 wells completed in December, 1885, as compared with 64 completed in January of the same year. The maximum number of wells completed during the year, however, was in October, being 397. This larger number of wells completed accounts in part for the increased daily production towards the close of 1885.

The following table shows the total number of drilling wells completed in this district for each of the years from 1872, and also the number completed in December of each year:

*Number of drilling wells completed in the Pennsylvania and New York oil fields in December and for the years 1872–'85.*

| Years. | December. | Totals. |
|---|---|---|
| 1872 | 105 | 1,183 |
| 1873 | 98 | 1,263 |
| 1874 | 120 | 1,317 |
| 1875 | 230 | 2,398 |
| 1876 | 272 | 2,920 |
| 1877 | 382 | 3,939 |
| 1878 | 165 | 3,064 |
| 1879 | 261 | 3,048 |
| 1880 | 302 | 4,217 |
| 1881 | 406 | 3,880 |
| 1882 | 122 | 3,304 |
| 1883 | 272 | 2,847 |
| 1884 | 66 | 2,265 |
| 1885 | 345 | 2,761 |

The average production of the wells completed in 1885 was smaller than for any year since 1878. The following table exhibits the average production per well for the years named:

| | *Barrels.* | | *Barrels.* |
|---|---|---|---|
| 1876 | 11.3 | 1881 | 20.0 |
| 1877 | 13.4 | 1882 | 35.0 |
| 1878 | 13.4 | 1883 | 15.4 |
| 1879 | 24.0 | 1884 | 29.2 |
| 1880 | 25.0 | 1885 | 16.2 |

The average per well was maintained very steadily in the three years of Bradford's highest development—1879, 1880, and 1881. In 1882 Cherry Grove increased the average largely. Cooper and Balltown gave but a small average in 1883, because there was enough drilling in the small well territory to keep it down. Thorn creek and Wardwell gave a large average in 1884, and last year the number of small wells completed kept down the average of Thorn creek and Cogley.

The highest average daily production of new wells during 1885 was in February when it was 41.3 barrels; the lowest in July, 10.3 barrels.

In the following tables will be found the statistics of petroleum production, shipments, stocks, and prices for the Pennsylvania and New York oil fields for a series of years, the tables giving the average and totals by months as well as by years:

## PRODUCTION STATISTICS.

*Total production of crude petroleum in the Pennsylvania and New York oil fields for the years* 1871–'85, *by years and months.*

| Years. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1871 | 418,407 | 372,568 | 400,334 | 385,980 | 408,797 | 410,340 | 456,475 | 462,582 | 461,940 | 485,243 | 464,610 | 477,958 | 5,205,234 |
| 1872 | 583,575 | 462,985 | 461,590 | 462,090 | 537,106 | 491,130 | 517,762 | 549,909 | 500,430 | 442,432 | 638,610 | 645,575 | 6,293,194 |
| 1873 | 632,617 | 608,360 | 665,291 | 641,520 | 776,364 | 793,470 | 867,473 | 936,138 | 954,270 | 942,493 | 991,470 | 1,084,380 | 9,844,744 |
| 1874 | 1,167,243 | 835,492 | 883,438 | 778,740 | 895,745 | 921,750 | 1,033,447 | 931,519 | 840,630 | 919,739 | 861,060 | 858,142 | 10,926,945 |
| 1875 | 852,159 | 719,824 | 789,539 | 675,060 | 696,508 | 696,210 | 788,361 | 718,766 | 698,940 | 731,073 | 700,200 | 720,874 | 8,787,506 |
| 1876 | 712,225 | 668,885 | 718,177 | 701,490 | 735,351 | 723,600 | 763,623 | 782,223 | 780,600 | 809,162 | 786,480 | 787,090 | 8,968,906 |
| 1877 | 842,890 | 873,216 | 901,697 | 972,810 | 1,127,594 | 1,130,790 | 1,189,005 | 1,273,759 | 1,214,910 | 1,269,326 | 1,173,420 | 1,256,058 | 13,135,475 |
| 1878 | 1,203,296 | 1,094,856 | 1,208,380 | 1,195,890 | 1,264,862 | 1,217,250 | 1,283,865 | 1,341,928 | 1,315,710 | 1,369,797 | 1,348,950 | 1,318,678 | 15,163,462 |
| 1879 | 1,369,921 | 1,261,935 | 1,499,315 | 1,530,450 | 1,644,922 | 1,675,650 | 1,687,767 | 1,892,302 | 1,856,700 | 1,836,378 | 1,710,480 | 1,709,356 | 19,785,176 |
| 1880 | 1,904,113 | 1,870,008 | 2,015,992 | 2,015,700 | 2,228,931 | 2,158,440 | 2,248,430 | 2,341,027 | 2,346,300 | 2,385,636 | 2,274,420 | 2,238,634 | 26,027,631 |
| 1881 | 2,244,090 | 1,913,128 | 2,274,532 | 2,205,780 | 2,393,293 | 2,377,860 | 2,372,678 | 2,331,727 | 2,193,420 | 2,323,171 | 2,266,830 | 2,480,000 | 27,376,509 |
| 1882 | 2,353,551 | 2,131,332 | 2,482,170 | 2,402,790 | 2,486,572 | 2,825,940 | 3,258,162 | 3,104,495 | 2,620,380 | 2,297,658 | 2,192,940 | 1,897,510 | 30,053,500 |
| 1883 | 1,948,319 | 1,756,188 | 1,830,674 | 1,816,530 | 1,962,052 | 1,977,900 | 2,020,394 | 1,879,437 | 1,913,370 | 2,076,659 | 1,958,340 | 1,988,526 | 23,128,389 |
| 1884 | 1,825,838 | 1,880,650 | 2,052,262 | 2,065,860 | 2,381,854 | 1,862,190 | 2,059,950 | 2,099,165 | 1,948,260 | 1,961,866 | 1,811,700 | 1,822,614 | 23,772,209 |
| 1885 | 1,652,176 | 1,437,884 | 1,638,133 | 1,780,290 | 1,771,371 | 1,767,210 | 1,775,804 | 1,705,961 | 1,712,790 | 1,874,105 | 1,761,660 | 1,898,657 | 20,776,041 |

*Shipments of crude petroleum, and refined petroleum reduced to crude equivalent, out of the Pennsylvania and New York oil fields for the years* 1871–'85, *by years and months.*

| Years. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1871 | 437,691 | 347,718 | 383,890 | 389,147 | 587,375 | 501,754 | 541,137 | 528,134 | 551,075 | 505,071 | 480,977 | 410,822 | 5,664,791 |
| 1872 | 476,966 | 407,606 | 276,220 | 428,512 | 510,417 | 529,228 | 591,238 | 621,954 | 541,607 | 607,468 | 477,945 | 430,786 | 5,899,947 |
| 1873 | 573,124 | 527,440 | 668,374 | 708,191 | 768,176 | 696,414 | 814,449 | 864,768 | 952,955 | 1,010,852 | 959,589 | 955,443 | 9,499,775 |
| 1874 | 813,663 | 501,220 | 518,246 | 803,409 | 899,027 | 815,413 | 940,281 | 793,865 | 1,014,570 | 543,341 | 546,117 | 602,348 | 8,821,500 |
| 1875 | 453,095 | 327,776 | 693,918 | 729,581 | 681,679 | 745,986 | 904,537 | 882,089 | 1,109,392 | 871,917 | 671,066 | 871,902 | 8,942,938 |
| 1876 | 677,289 | 519,193 | 621,762 | 603,037 | 646,150 | 921,862 | 1,228,539 | 1,203,402 | 1,154,549 | 524,190 | 871,496 | 1,190,983 | 10,164,452 |
| 1877 | 743,461 | 484,904 | 913,919 | 903,526 | 1,234,324 | 1,391,124 | 1,096,951 | 1,425,943 | 1,563,797 | 1,268,971 | 1,205,634 | 600,019 | 12,832,573 |
| 1878 | 775,791 | 774,234 | 741,512 | 846,632 | 960,894 | 1,135,119 | 1,330,454 | 1,655,651 | 1,434,225 | 1,747,390 | 1,281,410 | 992,688 | 13,676,000 |
| 1879 | 663,998 | 702,729 | 973,879 | 1,136,188 | 1,331,469 | 1,369,314 | 1,625,035 | 1,808,239 | 1,627,120 | 1,662,269 | 1,453,645 | 1,532,585 | 15,886,470 |
| 1880 | 1,650,409 | 1,395,151 | 1,613,371 | 842,268 | 1,095,259 | 975,083 | 1,231,611 | 1,394,129 | 1,252,635 | 1,665,933 | 1,226,030 | 1,335,613 | 15,677,492 |
| 1881 | 1,061,617 | 915,028 | 1,276,746 | 1,348,398 | 1,563,436 | 1,729,697 | 1,925,532 | 2,214,877 | 2,131,950 | 2,080,467 | 2,066,906 | 1,969,581 | 20,284,235 |
| 1882 | 1,657,067 | 1,787,909 | 1,718,956 | 1,678,134 | 1,827,356 | 2,072,685 | 2,402,970 | 2,047,515 | 1,992,171 | 2,089,428 | 1,404,640 | 1,121,453 | 21,900,314 |
| 1883 | 1,357,815 | 1,250,824 | 1,641,899 | 1,908,379 | 1,995,634 | 1,747,789 | 1,634,407 | 2,086,478 | 2,325,574 | 2,215,421 | 2,065,602 | 1,749,547 | 21,979,369 |
| 1884 | 1,686,961 | 1,723,261 | 1,873,890 | 1,643,336 | 1,899,329 | 1,827,553 | 1,740,021 | 2,000,371 | 2,292,087 | 2,510,283 | 2,078,261 | 2,382,244 | 23,657,597 |
| 1885 | 1,804,028 | 1,895,021 | 1,887,034 | 1,823,726 | 2,097,099 | 2,034,025 | 1,961,152 | 2,049,099 | 2,116,659 | 2,050,150 | 1,857,080 | 2,138,253 | 23,713,326 |

*Number of drilling wells in the Pennsylvania and New York oil fields at the close of each month for the years* 1871–'85, *by years and months.*

| Years. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Yearly averages. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1871 | 140 | 173 | 240 | 279 | 356 | 303 | 329 | 330 | 439 | 486 | 477 | 394 | 329 |
| 1872 | 363 | 369 | 313 | 302 | 386 | 391 | 359 | 392 | 301 | 311 | 354 | 318 | 347 |
| 1873 | 361 | 349 | 227 | 177 | 228 | 395 | 340 | 267 | 197 | 163 | 137 | 60 | 242 |
| 1874 | 37 | 55 | 99 | 213 | 225 | 210 | 180 | 128 | 107 | 82 | 57 | 54 | 121 |
| 1875 | 40 | 40 | 45 | 64 | 127 | 162 | 118 | 96 | 132 | 170 | 179 | 168 | 112 |
| 1876 | 142 | 151 | 230 | 267 | 307 | 340 | 353 | 374 | 511 | 565 | 618 | 493 | 363 |
| 1877 | 457 | 463 | 395 | 448 | 512 | 395 | 365 | 417 | 535 | 573 | 565 | 426 | 463 |
| 1878 | 334 | 326 | 379 | 409 | 376 | 266 | 188 | 185 | 240 | 282 | 297 | 218 | 292 |
| 1879 | 265 | 323 | 406 | 468 | 460 | 384 | 329 | 258 | 270 | 313 | 372 | 440 | 357 |
| 1880 | 540 | 535 | 577 | 580 | 460 | 440 | 452 | 515 | 491 | 469 | 475 | 408 | 495 |
| 1881 | 383 | 420 | 437 | 446 | 470 | 408 | 379 | 352 | 388 | 445 | 475 | 468 | 423 |
| 1882 | 422 | 438 | 408 | 405 | 381 | 226 | 240 | 194 | 177 | 184 | 154 | 138 | 276 |
| 1883 | 126 | 151 | 205 | 199 | 216 | 228 | 262 | 315 | 314 | 341 | 301 | 263 | 243 |
| 1884 | 270 | 273 | 260 | 284 | 244 | 123 | 123 | 91 | 79 | 100 | 86 | 78 | 168 |
| 1885 | 97 | 109 | 139 | 190 | 228 | 209 | 242 | 308 | 382 | 355 | 359 | 277 | 241 |

*Number of drilling wells completed in the Pennsylvania and New York oil fields each month for the years* 1872–'85, *by years and months.*

| Years. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1872 | 37 | 120 | 89 | 121 | 135 | 84 | 128 | 118 | 82 | 100 | 64 | 105 | 1,183 |
| 1873 | 93 | 94 | 100 | 105 | 102 | 130 | 114 | 120 | 106 | 101 | 100 | 98 | 1,263 |
| 1874 | 102 | 104 | 110 | 113 | 109 | 101 | 121 | 107 | 104 | 120 | 106 | 120 | 1,317 |
| 1875 | 190 | 187 | 195 | 186 | 172 | 190 | 200 | 210 | 201 | 220 | 217 | 230 | 2,398 |
| 1876 | 240 | 231 | 242 | 200 | 202 | 261 | 248 | 270 | 209 | 273 | 272 | 272 | 2,920 |
| 1877 | 281 | 241 | 291 | 269 | 320 | 403 | 317 | 255 | 322 | 467 | 391 | 382 | 3,939 |
| 1878 | 274 | 226 | 211 | 409 | 470 | 269 | 203 | 186 | 174 | 229 | 248 | 165 | 3,064 |
| 1879 | 156 | 132 | 238 | 270 | 402 | 330 | 327 | 283 | 210 | 232 | 227 | 261 | 3,048 |
| 1880 | 320 | 230 | 367 | 500 | 426 | 310 | 338 | 368 | 356 | 364 | 336 | 302 | 4,217 |
| 1881 | 222 | 220 | 271 | 316 | 406 | 374 | 336 | 332 | 312 | 322 | 363 | 406 | 3,880 |
| 1882 | 347 | 340 | 385 | 432 | 469 | 340 | 185 | 253 | 164 | 117 | 150 | 122 | 3,304 |
| 1883 | 125 | 126 | 142 | 209 | 231 | 228 | 261 | 309 | 321 | 321 | 302 | 272 | 2,847 |
| 1884 | 229 | 227 | 256 | 298 | 311 | 244 | 268 | 145 | 89 | 59 | 73 | 66 | 2,265 |
| 1885 | 64 | 62 | 82 | 116 | 213 | 242 | 217 | 283 | 356 | 397 | 384 | 345 | 2,761 |

*Number of producing wells in the Pennsylvania and New York oil fields at the close of each month for the years* 1872–'85, *by years and months.*

| Years. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Yearly averages. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1872 | 3,892 | 3,936 | 3,943 | 3,967 | 4,085 | 4,144 | 4,245 | 4,423 | 4,475 | 4,475 | 4,529 | 4,553 | 4,205 |
| 1873 | 4,485 | 4,490 | 4,411 | 4,265 | 4,317 | 4,400 | 4,420 | 4,163 | 3,940 | 3,654 | 3,413 | 3,358 | 4,109 |
| 1874 | 3,311 | 3,235 | 3,308 | 3,301 | 3,266 | 3,298 | 3,293 | 3,287 | 3,254 | 3,270 | 3,220 | 3,270 | 3,276 |
| 1875 | 3,132 | 3,112 | 3,060 | 3,052 | 3,080 | 3,084 | 3,067 | 3,088 | 3,112 | 3,125 | 3,174 | 3,078 | 3,098 |
| 1876 | 3,314 | 3,638 | 3,670 | 3,772 | 3,930 | 4,527 | 4,774 | 6,047 | 5,285 | 5,552 | 5,809 | 6,000 | 4,694 |
| 1877 | 6,283 | 6,441 | 6,666 | 6,846 | 7,037 | 7,352 | 7,564 | 7,684 | 7,872 | 8,061 | 8,323 | 8,458 | 7,383 |
| 1878 | 8,616 | 8,725 | 8,848 | 9,071 | 9,400 | 9,605 | 9,776 | 9,884 | 10,012 | 10,188 | 10,276 | 10,337 | 9,561 |
| 1879 | 10,482 | 10,582 | 10,692 | 10,782 | 11,045 | 11,223 | 11,461 | 11,585 | 11,760 | 11,860 | 11,960 | 11,960 | 11,283 |
| 1880 | 12,000 | 12,072 | 12,222 | 12,572 | 12,972 | 13,172 | 13,275 | 13,500 | 13,825 | 14,100 | 14,400 | 14,700 | 13,234 |
| 1881 | 14,900 | 15,050 | 15,500 | 15,769 | 16,150 | 16,700 | 17,000 | 17,250 | 17,562 | 17,799 | 18,040 | 18,300 | 16,668 |
| 1882 | 18,400 | 18,600 | 18,850 | 19,150 | 19,350 | 19,500 | 19,570 | 19,600 | 19,600 | 19,000 | 18,700 | 18,000 | 19,027 |
| 1883 | 17,600 | 17,300 | 17,250 | 17,100 | 17,100 | 17,050 | 17,100 | 17,100 | 17,300 | 19,100 | 20,406 | 20,606 | 17,918 |
| 1884 | 20,756 | 20,930 | 21,000 | 21,242 | 21,494 | 21,658 | 21,844 | 21,916 | 21,900 | 21,859 | 21,859 | 21,909 | 21,531 |
| 1885 | 21,950 | 21,987 | 22,042 | 22,093 | 22,223 | 22,384 | 22,524 | 22,688 | 22,775 | 23,062 | 23,295 | 23,519 | 22,546 |

*Average daily production of crude petroleum in the Pennsylvania and New York oil fields each month for the years* 1872–'85, *by years and months.*

| Years. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Yearly averages. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1872 | 18,825 | 15,965 | 14,890 | 15,403 | 17,326 | 16,371 | 16,702 | 17,739 | 16,681 | 4,272 | 21,287 | 20,825 | 17,194 |
| 1873 | 20,407 | 21,725 | 21,461 | 21,384 | 25,044 | 26,449 | 27,983 | 30,198 | 31,809 | 30,403 | 33,049 | 34,980 | 27,106 |
| 1874 | 37,653 | 29,839 | 28,598 | 25,958 | 28,895 | 30,725 | 33,337 | 30,049 | 28,021 | 29,669 | 28,702 | 27,682 | 29,937 |
| 1875 | 27,489 | 25,708 | 25,469 | 22,502 | 22,468 | 23,207 | 25,431 | 23,186 | 23,298 | 23,583 | 23,340 | 23,254 | 24,075 |
| 1876 | 22,975 | 23,065 | 23,167 | 23,383 | 23,721 | 24,120 | 24,633 | 25,233 | 26,020 | 26,102 | 26,216 | 25,390 | 24,505 |
| 1877 | 27,190 | 27,979 | 29,087 | 32,427 | 36,374 | 37,693 | 38,335 | 41,089 | 40,497 | 40,946 | 39,114 | 40,518 | 35,988 |
| 1878 | 38,816 | 39,102 | 38,980 | 39,863 | 40,802 | 40,575 | 41,415 | 43,288 | 43,857 | 44,187 | 44,965 | 42,538 | 41,544 |
| 1879 | 44,191 | 43,515 | 48,365 | 51,015 | 53,062 | 55,855 | 56,057 | 61,042 | 61,890 | 59,238 | 57,016 | 57,076 | 54,206 |
| 1880 | 61,423 | 64,552 | 65,032 | 67,190 | 71,991 | 71,948 | 72,530 | 75,517 | 78,210 | 76,956 | 75,814 | 72,214 | 71,114 |
| 1881 | 72,390 | 68,326 | 73,372 | 73,526 | 77,203 | 79,262 | 76,538 | 75,217 | 73,114 | 74,941 | 75,561 | 80,000 | 75,004 |
| 1882 | 75,921 | 76,119 | 80,070 | 80,093 | 80,212 | 94,198 | 105,102 | 100,145 | 87,346 | 74,118 | 73,098 | 61,210 | 82,338 |
| 1883 | 62,849 | 62,721 | 59,054 | 60,551 | 63,292 | 65,930 | 65,174 | 60,627 | 63,779 | 66,989 | 65,278 | 64,146 | 63,365 |
| 1884 | 58,898 | 64,850 | 66,202 | 68,862 | 76,834 | 62,073 | 66,450 | 67,715 | 64,942 | 63,286 | 60,390 | 58,794 | 65,129 |
| 1885 | 53,296 | 51,353 | 52,843 | 59,343 | 59,141 | 58,907 | 57,284 | 55,031 | 57,093 | 60,455 | 58,722 | 61,247 | 56,921 |

[Yearly average is total production divided by the number of days in year, *not* average of monthly averages.]

*Total stocks of crude petroleum in the Pennsylvania and New York oil fields for the years 1871–'85, by years and months.*

| Years. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Averages. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1871 | 537,751 | 587,021 | 642,000 | 771,000 | 605,000 | 554,000 | 511,220 | 530,146 | 541,300 | 495,102 | 502,960 | 532,000 | 567,458 |
| 1872 | 532,971 | 579,793 | 662,497 | 877,832 | 950,803 | 1,010,302 | 990,229 | 997,166 | 951,410 | 914,423 | 886,909 | 1,084,423 | 869,896 |
| 1873 | 1,183,728 | 1,265,373 | 1,244,657 | 1,178,643 | 1,192,541 | 1,324,493 | 1,433,620 | 1,513,890 | 1,521,185 | 1,452,777 | 1,493,875 | 1,625,157 | 1,369,191 |
| 1874 | 1,948,919 | 2,283,032 | 2,648,210 | 2,623,534 | 2,594,286 | 2,701,625 | 2,279,479 | 2,932,444 | 2,758,504 | 3,134,902 | 3,449,845 | 3,705,639 | 2,755,035 |
| 1875 | 4,011,703 | 4,546,188 | 4,592,361 | 4,537,843 | 4,552,672 | 4,502,896 | 4,386,720 | 4,223,397 | 3,812,945 | 3,672,101 | 3,701,235 | 3,550,207 | 4,174,189 |
| 1876 | 3,585,143 | 3,734,835 | 3,829,250 | 3,900,703 | 3,989,904 | 3,791,642 | 3,326,726 | 3,304,405 | 2,930,456 | 3,040,108 | 2,955,092 | 2,551,199 | 3,411,622 |
| 1877 | 2,604,128 | 2,860,636 | 3,210,454 | 3,279,731 | 3,173,608 | 2,912,674 | 3,004,728 | 2,852,544 | 2,503,657 | 2,504,012 | 2,471,798 | 3,127,837 | 2,875,434 |
| 1878 | 3,555,342 | 3,875,964 | 4,342,832 | 4,692,090 | 4,996,058 | 5,078,189 | 5,031,600 | 4,717,877 | 4,599,362 | 4,221,769 | 4,289,309 | 4,615,299 | 4,501,308 |
| 1879 | 5,321,222 | 5,813,663 | 6,318,099 | 6,689,111 | 6,980,064 | 7,263,150 | 7,353,382 | 7,114,195 | 7,620,525 | 7,794,634 | 8,051,469 | 8,470,490 | 7,065,834 |
| 1880 | 8,724,194 | 9,004,662 | 9,606,683 | 10,780,153 | 11,916,577 | 13,099,934 | 14,116,753 | 15,063,651 | 16,157,316 | 16,877,019 | 18,025,409 | 18,928,430 | 13,541,682 |
| 1881 | 20,110,903 | 21,108,003 | 22,105,789 | 22,963,171 | 23,793,028 | 24,441,191 | 24,888,337 | 25,005,187 | 25,066,657 | 25,309,361 | 25,509,285 | 26,019,704 | 23,860,051 |
| 1882 | 26,716,188 | 27,059,611 | 27,822,825 | 28,547,481 | 29,206,697 | 29,859,952 | 30,715,144 | 31,772,094 | 32,400,303 | 32,608,533 | 33,728,555 | 34,596,612 | 30,419,499 |
| 1883 | 35,187,116 | 35,692,480 | 35,881,255 | 37,789,406 | 35,755,824 | 35,985,935 | 36,371,922 | 36,164,881 | 35,752,677 | 35,613,915 | 35,506,653 | 35,745,632 | 35,953,975 |
| 1884 | 35,884,509 | 36,041,898 | 36,220,270 | 36,642,794 | 38,631,203 | 38,665,838 | 38,985,767 | 39,084,561 | 38,740,734 | 38,192,317 | 37,925,756 | 37,366,126 | 37,698,481 |
| 1885 | 37,214,274 | 36,757,137 | 36,508,236 | 36,464,800 | 36,139,072 | 35,872,257 | 35,686,909 | 35,343,771 | 34,939,902 | 34,763,857 | 34,668,437 | 34,428,841 | 35,732,291 |

*Monthly and yearly average price of pipe-line certificates or crude petroleum at well for the years 1860–'85.*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1860 | $19.25 | $18.00 | $12.62½ | $11.00 | $10.00 | $9.50 | $8.62½ | $7.50 | $6.62½ | $5.50 | $3.75 | $2.75 | $9.59 |
| 1861 | 1.00 | 1.00 | 1.00 | .62½ | .50 | .50 | .50 | .25 | .20 | .10 | .10 | .10 | .49 |
| 1862 | .10 | .15 | .22½ | .50 | .85 | 1.00 | 1.25 | 1.25 | 1.25 | 1.75 | 2.00 | 2.25 | 1.05 |
| 1863 | 2.25 | 2.50 | 2.62½ | 2.87½ | 2.87½ | 3.00 | 3.25 | 3.37½ | 3.50 | 3.75 | 3.85 | 3.95 | 3.15 |
| 1864 | 4.00 | 4.37½ | 5.50 | 6.56 | 6.87½ | 9.50 | 12.12½ | 10.12½ | 8.87½ | 7.75 | 10.00 | 11.00 | 8.06 |
| 1865 | 8.25 | 7.50 | 6.00 | 6.00 | 7.37½ | 5.62½ | 5.12½ | 4.6?½ | 6.75 | 8.12½ | 7.25 | 6.50 | 6.59 |
| 1866 | 4.50 | 4.40 | 3.75 | 3.95 | 4.50 | 3.87½ | 3.00 | 3.75 | 4.50 | 3.39 | 2.10 | 2.12½ | 3.74 |
| 1867 | 1.87½ | 1.85 | 1.75 | 2.07½ | 2.35 | 1.90 | 2.62½ | 3.15 | 3.40 | 3.55 | 2.50 | 1.87½ | 2.41 |
| 1868 | 1.95 | 2.00 | 2.55 | 2.82½ | 3.75 | 4.50 | 5.12½ | 4.57½ | 4.00 | 4.12½ | 3.75 | 4.35 | 3.62½ |
| 1869 | 5.75 | 6.95 | 6.00 | 5.70 | 5.35 | 4.95 | 5.37½ | 5.57½ | 5.50 | 5.50 | 5.80 | 5.12½ | 5.63¾ |
| 1870 | 4.52½ | 4.52½ | 4.45 | 4.22½ | 4.40 | 4.17½ | 3.77½ | 3.15 | 3.25 | 3.27½ | 3.22½ | 3.40 | 3.86 |
| 1871 | 3.82½ | 4.38 | 4.25 | 4.01 | 4.60 | 3.85½ | 4.79 | 4.66 | 4.65 | 4.82½ | 4.25 | 4.00 | 4.34 |
| 1872 | 4.02½ | 3.80 | 3.72½ | 3.52½ | 3.80 | 3.85 | 3.80 | 3.58½ | 3.25 | 3.15 | 3.83½ | 3.32½ | 3.64 |
| 1873 | 2.60 | 2.20 | 2.12½ | 2.30 | 2.47½ | 2.22½ | 2.00 | 1.42½ | 1.15 | 1.20 | 1.25 | 1.00 | 1.83 |
| 1874 | 1.20 | 1.30 | 1.60 | 1.90 | 1.62½ | 1.32½ | 1.02½ | .95 | .95 | .85 | .55 | .61½ | 1.17 |
| 1875 | 1.03 | 1.52½ | 1.75 | 1.36½ | 1.40 | 1.26½ | 1.09 | 1.13 | 1.33 | 1.32½ | 1.44 | 1.55 | 1.35 |
| 1876 | 1.80 | 2.60 | 2.01 | 2.02½ | 1.90½ | 2.01¾ | 2.24⅛ | 2.71⅜ | 3.81 | 3.37½ | 3.11 | 3.73 | 2.56¼ |
| 1877 | 3.53¼ | 2.70 | 2.67½ | 2.58 | 2.24 | 1.94⅜ | 2.07½ | 2.51 | 2.38 | 2.56⅜ | 1.91 | 1.80 | 2.42 |
| 1878 | 1.43 | 1.65¼ | 1.59 | 1.37½ | 1.35¼ | 1.14 | .98¾ | 1.01 | .86⅜ | .82⅛ | .89⅜ | 1.16 | 1.19 |
| 1879 | 1.03 | .98 | .86½ | .78½ | .76 | .62⅜ | .69⅞ | .67⅛ | .69⅜ | .88⅛ | 1.05⅜ | 1.18½ | .85⅞ |
| 1880 | 1.10¼ | 1.03½ | .88¾ | .78 | .80 | 1.00 | 1.06½ | .91 | .96 | .96⅞ | .91⅞ | .91⅜ | .94½ |
| 1881 | .95½ | .90⅜ | .83⅜ | .86¼ | .81⅞ | .81¼ | .76⅞ | .78½ | .97 5/16 | .91¾ | .85¼ | .84⅜ | .85⅞ |
| 1882 | .83½ | .84½ | .81⅜ | .78⅜ | .71½ | .54⅜ | .57 5/16 | .58⅝ | .72⅜ | .93¾ | 1.14 | .96 | .78⅝ |
| 1883 | .93¾ | 1.01 | .97⅛ | .92⅜ | 1.00⅛ | 1.16⅜ | 1.05⅞ | 1.08½ | 1.12½ | 1.11⅛ | 1.14½ | 1.14¾ | 1.05¾ |
| 1884 | 1.11 | 1.04⅜ | .98⅛ | .94 | .85⅝ | .68⅜ | .63½ | .81⅛ | .78 | .71⅛ | .72½ | .74⅜ | .82½ |
| 1885 | .70⅞ | .72⅜ | .80½ | .78½ | .79 | .82 | .92½ | 1.00¼ | 1.00¾ | 1.05½ | 1.04⅜ | .89⅞ | .87⅞ |

## OHIO.

Petroleum has been found in a number of localities in Ohio, in Lorain, Trumbull, Washington, Noble, Morgan, Columbiana, and Knox counties. By far the most important of these localities are the Macksburg, in the neighborhood of Marietta, in Washington county.

One of the earliest wells bored in the Macksburg district was in 1860. This well was 56 feet deep and yielded many thousand barrels of heavy lubricating oil. Reports would indicate that the daily yield at first was from 100 to 200 barrels. The Buell well, in the same locality, produced oil steadily for a number of years. A well a short distance east of the Buell well, yielded at first 150 barrels a day. This Macksburg region assumed, however, but little importance until the spring of 1884, when a number of successful wells were bored. During 1885 the production in this district increased rapidly, the runs through the Macksburg pipe lines being 613,822 barrels. It is evident, however, that the Macksburg district under present conditions has reached its highest point of development, the production of this field having shown a steady decline for some months past. In August, 1885, the daily production was 2,382 barrels; in September, 2,270; in October, 2,053, and in November, 2,031.

Mecca, Trumbull county, yields a few hundred barrels per year from the shallowest of wells. The oil is brought up by hand in sand pumps. Its lubricating quality gives it value. The production in this section is continuous. Source, Berea Grit. The oil is sold to farmers and country stores, so that it cannot be traced.

Grafton, Lorain county, yields a few score of barrels of same or similar quality to the Mecca. Production, however, is almost at an end; the source is the Berea Grit.

Athens county and Morgan county yield a little shallow oil from a coal-measure sandstone. The wells are worked by hand. The oil is hauled away in barrels or sold to the farmers of the neighborhood. The production is insignificant.

The new field of Limestone oil is centered at Lima. It is now yielding several hundred barrels per diem.

## WEST VIRGINIA.

Petroleum has been known to exist in Virginia from the earliest times. As far back as 1771 Jefferson gave an interesting description of a burning spring and the oil connected with it in the Great Kanawha valley. Up to 1865, however, no oil had been produced, except in a speculative way in attempts to develop the resources of the State. In this and the succeeding year, operations commenced almost simultaneously at Burning Spring, Oil Rock, California House, Volcano, Sand Hill, and Horse-Neck. Considerable quantities were found at all of these points, light oil being obtained at all of these places except at Volcano and Sand Hill. These two localities produced heavy oils.

The light-oil regions ran a rapid course, giving a large yield during their productive career, and have ceased to be of importance. The heavy-oil districts, however, still continue to produce.

In 1876 it was estimated that the production of oil in West Virginia up to that time had been three million barrels, varying in specific gravity from 27 to 45 degrees Beaumè, the greater portion varying from 27 to 33 degrees. At present the production of oil in this State is small and entirely of the lubricating variety.

## KENTUCKY.

Little can be added to the statement contained in the last volume of "Mineral Resources" as to the occurrence of petroleum in Kentucky. The wells near Glasgow have yielded steadily a small quantity of oil for a number of years, and, being convenient to the Louisville and Nashville railroad, it is very probable they were worked with profit. The product was refined by Chess, Carley & Co., Louisville, Kentucky.

## TENNESSEE.

The oil territory of Tennessee occupies the extreme southern end of the great oil belt, which extends in a southwesterly direction, at least from the wells near Petrolea in Ontario to just across the Tennessee line in Alabama. Indications of oil have been found in many counties in the State, but chiefly in Overton, Clay, Putnam, Jackson, and Fentress. These counties belong mainly to the Highland Rim, or that portion of the State which surrounds, like the rim of a dish, a great central basin in the interior of the State.

The most productive of the oil developments of this State, and probably of the South below West Virginia, was in Overton county, but the wells are too far from market to make the production of oil profitable at the prices that have been ruling in Pennsylvania for years. From a recent article by Prof. H. E. Colton, on the petroleum of this State, we extract the following:

"In 1865 and 1866 thirteen wells were sunk in Overton county, which produced good quantities of oil; of these the first, called the Newman well, produced 2,600 barrels of oil at a depth of 20 feet; at 51 feet it produced an immense quantity of oil which was lost. This well flowed steadily for three months. Colonel Irwin reports that he shipped 5,000 barrels to Nashville in 1866. It is impossible to say how much oil this well produced, but it was a large quantity.

"In 1866 three other wells were sunk near the above. No. 1 at 52 feet yielded 30 barrels per day for four weeks. The flow lessening, it was sunk to 68 feet, and a yield of 110 barrels per day obtained, which continued for two years and three months by being pumped. It was abandoned on account of costly transportation. No. 2 was bored to a depth of 55

feet, and oil reached. It yielded by pumping 25 barrels per day for about three years. In No. 3, oil was reached at 53 feet and 160 barrels per day pumped out for over a year, when an accident caused the abandonment of the well. A number of other wells were bored in the neighborhood; in some, small quantities of oil were obtained, in others none. It has been estimated that 15,000 barrels of oil were lost at the Newman well. From the other three noted there are records of the shipment of 6,813 barrels.

"At other points in Overton county wells were bored and oil obtained, as also in counties on the northeast and southwest. In many of the wells bored immense quantities of gas were struck, in some to such an extent as to force out the tools used in boring. In Cannon county in an ordinary well oil accumulates so rapidly that two or three barrels can be gathered daily. It is an excellent article of lubricating oil. A similar oil was found in the northeast part of Sumner county.

"The Dickson County oil region was on Jones's creek, about 6 miles from the Nashville, Chattanooga and Saint Louis railroad. While the Overton wells were none of them sunk below the black shale, and all the oil obtained above it, the wells of Dickson were all sunk in strata below it, and the oil there obtained, apparently in a bed of gravel. Just below the black shale in this region exists a sandrock similar to the oil sandstones of Pennsylvania, and it is heavily charged with petroleum. At its outcrop, however, it is only about 5 feet thick. Four wells were bored in this region, most of them yielding an immense quantity of gas. The greater part of the oil was obtained from wells 100 to 150 feet deep. About 300 barrels are said to have been saved from these wells and hauled to Nashville, about 30 miles. Some parties are now boring there for natural gas."

It is evident from these statements that but little oil has ever been produced and utilized in this State.

## CALIFORNIA.

From the time of the first settlement of California by the whites there have been evidences, in the form of springs and seepage from the asphaltum beds, of the existence of petroleum in the State. No attempts, however, were made to utilize these deposits until the excitement following the Pennsylvania oil discoveries led to prospecting these surface deposits and the eager searching for others. During the years 1865 and 1866 upwards of seventy companies, each with a large nominal capital, were incorporated in California for the purpose of searching for petroleum. While a majority of these companies proceeded no further than to organize, having never expended any money in actual operations, some of them began active operations, sinking wells and driving tunnels in their search. Most of the work at this time was in Humboldt, Colusa, Contra Costa, Santa Clara, and Los Angeles counties.

A large amount of money was spent, but no considerable deposit of oil was found. The most promising field was developed in Los Angeles county.

Discouraged at the result of these first efforts, search for oil after a year or two was almost entirely abandoned, but little attention having been given to this industry for the next ten years. The opinion of Whitney and other eminent geologists, to the effect that no such deposits of petroleum as those developed in Pennsylvania would be found in California, added to this discouragement. This opinion was based on the absence in California of extensive coal beds. The tilted condition of the rock, consisting largely of slate, was thought not to admit of the retention of large quantities of oil in pools, such as occur in the horizontal sandstone strata of New York and Pennsylvania.

Faith was not, however, wholly lost in the petroleum resources of California. Some still believed them to be considerable, their argument being that where so much oil appeared on the surface it could not all escape downward through the vertical strata, and that only deeper borings were required to demonstrate the existence of heavier deposits than had yet been found, but few of these pioneer wells having reached a greater depth than 400 or 500 feet.

Although experience has not fully borne out this last conclusion, many of the wells since sunk having yielded liberally at no great depths, still it strengthened the determination of the oil men to persevere in the work of exploration, and drilling was kept up, though in a feeble and desultory way, for seven or eight years after it had been generally abandoned. A good many wells were sunk, chiefly in Ventura and Los Angeles counties. Some of the borings here were carried to considerable depths. Most of these wells yielded oil in small quantities, usually from 6 or 8 to 10 or 12 barrels per day. A number of small refineries were also put in operation at different localities, but they all proved short-lived, not being able to make the business profitable, and, with the exception of a demand from the Central Pacific Railroad company for some 200 barrels per month for lubricating purposes, there was little market for the crude material.

About 1875 the oil business in California began to revive. Two wells put down that year yielded some 15 or 20 barrels each per day. Drilling by steam began to be more generally used in place of the spring pole. In 1877 the Ventura and the Pico Cañon wells produced daily 80 and 40 barrels respectively. Some 20 barrels of refined oil were made daily at the Pico refinery at the latter place. The next year 60 barrels of crude oil were for a number of days taken from the Boyer well, in the Santa Cruz mountains, every 24 hours. The oil here, as in most cases in California, was brought to the surface by pumping, no flowing wells having as yet been struck in the State.

From this time there has been a steadily increasing output of oil in California. The annexed table, showing the annual and total production

of petroleum in this State from 1878 to 1885, inclusive, indicates the progress made and the proportions to which this industry has there attained:

*Production of petroleum in California since* 1878.

| Years. | Barrels. |
|---|---|
| 1878 | 15,227 |
| 1879 | 19,858 |
| 1880 | 40,552 |
| 1881 | 99,862 |
| 1882 | 128,636 |
| 1883 | 142,857 |
| 1884 | 262,000 |
| 1885 | 325,000 |
| Total | 1,033,992 |

Added to the above, say 200,000 barrels to cover the output prior to 1878, we have as the total product of petroleum in California to the close of 1885, 1,233,992 barrels.

The quantity of refined petroleum brought into California from eastern seaports during the past five years has been as follows:

| Years. | Gallons. |
|---|---|
| 1881 | 1,534,354 |
| 1882 | 1,048,290 |
| 1883 | 3,073,000 |
| 1884 | 2,986,738 |
| 1885 | 4,320,820 |

The exports of petroleum from the port of San Francisco have averaged, of late years, about 3,000,000 gallons per annum. These exports are mainly to China, Japan, British Columbia, Asiatic Russia, and the Pacific islands, San Francisco being the distributing point for the countries lying along, and adjacent to, the Pacific coast to the north and the south of that port.

The consumption of petroleum in California amounts annually to about 6,000,000 gallons. Importations are made both overland and by sea. The principal importers are the Standard Oil Company and the Beacon Light Oil Company.

The principal producer and refiner in California is the Pacific Coast Oil Company, which, besides its own product, control that of most of the smaller companies, but few of which have any longer an individual existence. The Pacific Coast Company is the owner of 21 wells, the most of which are producing. It keeps up in the oil territory, which it owns or controls, what amounts to 64,000 acres in Los Angeles county, 62,000 acres in Ventura, and about 32,000 in Santa Cruz, Santa Clara, and San Mateo counties. This covers, probably, the most valuable of the petroleum deposits in the State. Commencing active operations in 1875, this company has since expended, in the purchase

of lands, sinking wells, erecting refineries, laying down pipe lines, and in making other improvements a sum approximating $3,000,000. In addition to the lands and wells mentioned, this company has two refineries—one located at Newhall, in Los Angeles county, the other at Alameda Point, on the opposite side of the bay, and distant 6 miles from the city of San Francisco. These latter works were erected at a cost of nearly $200,000, and are quite extensive and complete. The present refining capacity of these works is 500 barrels per day, but they have been planned with a view to their easy enlargement to six times that capacity when future requirements may call for it. This company last year put down 40 miles of 2-inch iron pipe, extending from Newhall to Santa Paula, where it connects with a similar pipe laid by the Mission Transfer Company and reaching from Santa Paula 20 miles south to the port of San Buena Ventura, making a continuous pipe line 65 miles in length. This last improvement cost the company, pumping plant included, $65,000. They have also 6 miles of pipe laid for conveying the oil from their wells in Pico cañon to their refinery at Newhall. For transporting the oil to their works at Alameda Point two methods are in use—one by steamer from Buena Ventura, and the other by rail from the town of Newhall—large storage tanks having been erected at each of these points.

The Pacific company produce an average of about 600 barrels of crude petroleum per day. The only other companies that are producing in any quantity in California are the Mission Transfer, the wells of which are located in Ventura county, and the firm of Rowland & Lacey, with a well at Fuente, 22 miles east of the city of Los Angeles. The production of the latter well is 15 barrels per day; of the Mission company about 75 barrels; all of which is handled by the Pacific company. It is not refined, but sold in its natural state for fuel, for which it is better adapted than for refining. The use of crude petroleum and the residuum of the refineries for generating steam, manufacturing gas, etc., is rapidly extending in California, the cost of coal and other fuels, more especially in the southwestern portions of the State and in the adjoining Territory of Arizona, greatly favoring its introduction there. The Central Pacific Railroad companies have for the past year been using it as fuel on their large ferry steamers plying on the bay of San Francisco. It is also used as fuel on some of the Sacramento river boats and freight steamers on the bay. Some of the tug-boats use it also. The success of the liquid fuel has induced the company to try it as fuel on locomotives, and experiments are now being made by Master Mechanic Stevens with freight locomotives. He informs the writer, however, that he is not yet prepared to make the results public, as the tests are not concluded.

Crude petroleum must always be a cheap commodity in California, having a wide distribution. It has been found in eighteen of the fifty-two counties of the State and will probably yet be found in some others. Although the deposits thus far developed have not, except in

two or three counties, proved very abundant or permanent, there is a chance that many of them may improve in this respect on greater depths being reached.

The principal oil belt in this State, so far as development and production are concerned may be said to commence at Santa Paula, in Ventura county, and to extend thence in a southeasterly direction about 60 miles to Fuente, in Los Angeles county, taking in the Sespe and other wells in Ventura county, Pico cañon, Newhall, etc., this belt having a variable width of two or three miles, there being many oil indications and unimportant deposits on either side of it.

The life of an oil well in California has not yet been determined, none of the larger producing wells having entirely failed. Generally they fall off in a few years to the extent of 35 per cent., continuing afterwards to produce at about that rate. The Pico well in the San Fernando district, opened 9 years ago, and which has since produced a total of 160,000 barrels of oil, continues to yield at the rate of 12,000 to 14,000 barrels per annum. The largest yield of any well opened was 110 barrels per day. This was in the San Fernando district, where not more than five or six of the many wells sunk failed to yield some oil. While it costs twice as much to sink a well in California as in Pennsylvania, the value of a producing well is three times as much in the former as in the latter State.

Although comparatively few wells are now being sunk in California, all the larger companies continue the work of prospecting and boring, a number of small companies and individuals are also similarly engaged; nor is it at all unlikely that the business of searching after the earth oils will, before long, undergo some revival in that State. Some oil has been found in San Mateo county and also in Alameda county, at both of which places companies are now boring and prospecting in the endeavor to find paying wells.

In the latter part of 1885 workmen sinking a well in the city of Los Angeles encountered a flow of natural gas. The locality, though not within the limits of the more productive oil belt, being in the vicinity of heavy deposits of asphaltum and other oil signs, encourages the hope that other and stronger flows of this natural gas will yet be struck in that district, where it could be utilized to great advantage.

### WASHINGTON TERRITORY.

As yet no valuable deposits of petroleum or its concomitant asphaltum have been found anywhere in the far West, except in California. Recently encouraging indications of mineral oil are reported to have been met with at Puyallup, in Washington Territory. These have been so encouraging as to lead to the organization of a local company to prospect the deposits. This company having procured suitable machinery, commenced boring towards the end of the year, and at last accounts had passed through several strata of gravel, yielding more or less oil, and felt confident that they would, at no great depth, strike a

paying deposit. This well is being sunk on the bank of the Puyallup river, a few miles above the town of Puyallup. In many places in this neigborhood, natural gas escapes from the ground upon making holes. This gas on being ignited burns freely.

## WYOMING.

The year 1885 has been marked in the Wyoming oil regions by a great amount of work in development, and some results which are remarkable as evidencing the extent of the oil field and the large amount of oil to be obtained, if not over the whole field, at any rate in places quite distant from each other.

There are, as far as now known, two oil fields in this Territory, probably originally the same, but now divided by the range of mountains in which the headwaters of the North Platte and Wind rivers find their sources. The field at the head of the North Platte and Wind rivers may be called the North Platte field. It occupies parts of Johnson, Fremont, and Carbon counties, the nearest point on the railway at present being Rawlins, on the Union Pacific.

The area and outline of the oil-bearing region have been only approximately determined by the occurrence of oil springs or springs whose waters are contaminated with petroleum products. The continuity of the oil-bearing sands is also fairly well determined. The area of the North Platte field, it is stated by prospectors in this section, is about 132 by 72 miles, or 5,500 square miles—enough, if petroleum is found throughout it, to supply an unlimited future demand.

The oil is found in two strata, the upper a black sand averaging generally 70 feet in thickness. The other is a "black pebble" or dark conglomerate varying in thickness according to various authorities from 400 to 800 feet. All the oil heretofore found by boring is in the upper or 70-foot sand.

The only producing wells heretofore obtained have been on what is known as the Graff property, at the head of the south branch of the Little Wind river, in Fremont county. The company owning the ground is styled the Wyoming Central Oil and Transportation Company. Through the energy and perseverance of the late Dr. George B. Graff, of Omaha, four wells were sunk to the upper oil-bearing sand.

The depth of these wells and their product is as below:

| Well. | Depth in feet. | Flow per day in barrels.[a] |
|---|---|---|
| No. 1 | 85 | 85 |
| No. 2 | 100 | 100 |
| No. 3 | 350 | 325 |
| No. 4 | 1,200 | 825 |
| Total | ..... | 1,335 |

[a] As these wells are plugged, and as the only accurate gauge of wells is obtained when the oil is run into tanks and measured, these figures of flow must be taken with some allowance.

All these wells are now plugged. The general dip of the strata here is about 5°, and the close connection between the depth of the well and the amount of oil flowing is readily observable.

The flow of oil from the deeper wells is accompanied by large quantities of gas, and the oil rises above the derricks. The tubing generally adopted throughout this section is 5§ inches in diameter.

On the head of the North Platte, on the Poison Spider and other creeks several other companies have prosecuted development work with no great amount of success so far. The Denver and Wyoming Land and Improvement Company has one well to the upper sand but no oil. The Denver Land and Placer Company and the Wyoming Central Association have no wells down. The Wyoming Central Syndicate has a well in Johnson county down 650 feet, but no oil yet.

Small incorporated operators are sinking elsewhere, but so far the development has not proceeded far enough to secure good results. The work of practical sinking was begun only during the summer of 1885, and the time for development has been but short.

The oil obtained here is a black oil, unsuitable for lubricating. Some tests of it have been made, but not enough to establish its uniform character definitely.

Some of the oil taken from surface springs is heavy, but that from the wells is much lighter and thinner. Tests made in December, 1885, of some of the oil from the wells showed a specific gravity of 24 degrees Baumé.

The other field in which fair results have been reached by boring is on the Bear river, in Uinta county. North of Evanston some little boring has been done, but no definite information has been obtained except with regard to one well on Twin creek, one mile from Fossil Station, on the Oregon Short Line railway. This well was visited personally in the summer of 1885, and found to be only about 100 feet deep. All the boring had been done with a spring pole.

There was a large flow of brackish water with which the oil globules came up. No attempt had been made to save the oil beyond the construction in a little ravine of two small earthen reservoirs, the water being drained away below.

Some gallons of the oil had been taken by the Union Pacific to be tested, with the following result:

*Test of oil from Clark & Tisdell's well at Fossil, Wyoming.*

| | Beaumé. |
|---|---|
| Specific gravity | 26.75 |
| Flashing point | 1.70 |
| Burning point | 2.20 |
| *After 10 hours heating at 200°.* | |
| Gravity | 24.75 |
| Flashing point | 2.40 |
| Burning point | 2.68 |
| Comparative value of crude oil as— | |
| Lubricant (No. 1 lard oil=100)= | 85 |
| Value of oil (standard=100)= | 84.695 |

The oil is heavy, black and apparently suitable for lubricating purposes. Its economic value to the Union Pacific railway will be great on account of the proximity of the track to the well.

# NATURAL GAS.

By Joseph D. Weeks.

The term "natural gas" is the one almost universally applied to that mixture of several gases found by drilling in certain sections of the country; chiefly, and in the largest quantities, in western Pennsylvania and northern Ohio. This gas is also found escaping from some springs, the banks of rivers, and other similar localities.

As will appear in discussing its composition and analysis, this gas is chiefly marsh gas, ethane, hydrogen, and nitrogen. The name "natural gas" was applied to it to distinguish it from the artificially prepared gases of commerce, especially from ordinary illuminating gas, and from producer fuel gases, which, as well as water gas, are made from coal.

The propriety as well as the exactness of the name has recently been called in question, and other names have been used. Prof. Edward Orton, State geologist of Ohio, speaks of it usually as natural gas, but also as "inflammable gas"; while Prof. J. P. Lesley, State geologist of Pennsylvania, following the analogy of the name petroleum, applies to it the name "rock gas."

While it is true that the name "natural gas" does not exclusively belong to the gas we are considering, it seems to be as fairly descriptive of it as the other names suggested. If there are other "natural gases", there are also other "inflammable" and other "rock" gases, and as the adjective "natural" is descriptive of one of its characteristics and is so universally in use, there seems to be no good and sufficient reason why it should be discarded for any substitute that has yet been suggested.

### TOTAL CONSUMPTION OF GAS.

It is simply impossible to ascertain the total production in cubic feet of natural gas in the United States. The data do not exist for such a statement. But few wells have been accurately measured and even these measurements when made, only give the rate of production for the moment when the observations are taken. This rate changes not only from day to day, but from hour to hour, and even from moment to moment. It is usually greater at certain times of the day, as in the morning, than at others. It varies with the weather and with the state of the barometer.

Nor is it essential to ascertain this total production of all wells. The only production that has any commercial importance is that which is

utilized. The amount that is wasted has no commercial value, at least that can be considered. Only that gas which has been consumed in doing useful work will be taken into consideration in this statement of total consumption. The waste cannot be considered.

The basis of the calculation of consumption is the amount of coal displaced by the gas. When coal is not used in the locality, or where it furnishes only a portion of the fuel, the value of wood or other fuel used is regarded as the value of coal displaced, and an estimate of the tonnage of coal that would be displaced is made, based on the selling price of coal in the locality.

The total displacement of coal by gas and the value of the same is as follows:

*Amount of coal displaced by natural gas in* 1885 *and its value.*

| Locality. | Coal displaced, short tons. | Value. |
|---|---|---|
| Pennsylvania: | | |
| Allegheny county | 2,000,000 | $2,500,000 |
| Balance Pittsburgh district | 500,000 | 750,000 |
| Western Pennsylvania outside Pittsburgh district | 500,000 | 1,250,000 |
| New York | 56,000 | 196,000 |
| Ohio | 50,000 | 100,000 |
| West Virginia | 20,000 | 40,000 |
| Illinois | 600 | 1,200 |
| Elsewhere | 5,000 | 20,000 |
| Total | 3,131,600 | $4,857,200 |

As indicating the methods by which this estimate was reached, it may be stated that the estimate for Allegheny county is the result of several methods of computation. In the first place, the charges for the use of natural gas are based upon the amount of coal displaced, so that the natural gas companies can approximate to the coal displacement, knowing how many consumers they have and for what purposes the gas is used. A number of persons connected with these companies are of the opinion that when the mills and factories were in full operation the coal displaced by natural gas was 10,000 tons daily in 1885. Sundays, holidays, stoppages, partial time, and light running would make the time equal to say two hundred days full time and the coal displacement 2,000,000 short tons a year.

A very careful estimate of the actual amount of coal consumed at each of the iron and steel mills and glass works and other large establishments using gas gave an aggregate of a little less than 50,000,000 bushels; one estimate is 48,000,000 bushels. Add to this amount 3,500,000 bushels of coal displaced by gas in domestic use and small establishments, and the total displacement would be from 51,500,000 to 53,500,000 bushels yearly. Now, 53,000,000 bushels are equivalent to 2,000,000 short tons, so that these two methods give about the same results.

*Estimated amounts of coal displaced by gas daily at individual iron and steel works in Pittsburgh.*

| Name of company. | Coal displaced daily by gas. | Name of company. | Coal displaced daily by gas. |
|---|---|---|---|
| | *Bushels.* | | *Bushels.* |
| Oliver Bros. & Phillips | 15,000 | Phillips, Uimick & Co | 3,800 |
| Jones & Laughlins, limited | 15,000 | Keystone Rolling Mill Company | 3,800 |
| Graff, Bennett & Co | 14,000 | Brown & Co | 3,500 |
| J. Painter & Sons | 10,000 | Dilworth, Porter & Co | 3,000 |
| Carnegie Bros. & Co. (Union mills) | 10,000 | Wm. Clark & Co | 3,000 |
| Park Bros. & Co | 8,000 | Moorhead Bros. & Co | 3,000 |
| Hussey, Howe & Co | 8,000 | Singer, Uimick & Co | 3,000 |
| Shoenberger & Co | 7,000 | Chess, Cook & Co | 2,600 |
| Miller, Metcalf & Parkin | 6,000 | H. Lloyd, Sons & Co | 2,500 |
| A. M. Byers & Co | 5,000 | J. W. Friend & Co | 2,000 |
| Lindsay & McCutcheon | 5,000 | Republic Iron Works | 2,000 |
| Zug & Co | 5,000 | Everson, Hammond & Orr | 2,000 |
| Spang, Chalfant & Co | 4,500 | Spang Steel and Iron Works | 2,000 |
| Elba Iron and Bolt Works | 4,000 | La Belle Steel Works | 2,000 |
| Morehead, McCleane & Co | 4,000 | | |

It is estimated that window glass works require on an average 400 bushels of coal daily, flint and bottle houses 200 bushels. Domestic consumption is placed at 700 bushels a year per house. These items are given as showing the basis of the estimates.

As showing the number of consumers the following is given as the number supplied at the close of 1885 in Pittsburgh by the Philadelphia company alone:

| | |
|---|---|
| Iron and steel works | 46 |
| Glass works | 33 |
| Oil refineries | 9 |
| Various manufactories | 101 |
| Houses and stores | 2,637 |

It may be stated that at the close of 1885 the estimated displacement of coal by the gas of the Philadelphia company was 9,000 tons and the consumption of gas daily 182,400.000 cubic feet.

In reaching an estimate of the amount consumed outside of Allegheny county and the Pittsburgh district, a computation similar to that given in connection with the New York oil fields was used. As great a proportion of the oil wells of western Pennsylvania are neither pumped nor drilled with gas as in New York, but there is a larger consumption for other purposes. In addition to this method of computation the consumption was checked by some twenty reports from different localities as to coal displaced. It is believed that 500,000 tons of coal displacement is as close an estimate as it is possible to make.

At Fredonia, New York, the total production of gas is stated to have been 6,000,000 cubic feet in 1885, an amount which is estimated by Mr. E. J. Crissey, superintendent of the Fredonia Natural Gas Light company, to have displaced 50 tons of coal valued at $5 a ton. Some wood was also displaced; including this, the total gas would be equal to about 150 tons of coal displaced at $5 a ton. At Westfield the gas is only used for illumination, the total consumption in 1885 being but some 500,000

cubic feet, about equal to the displacement of 13 tons of coal at $5 a ton. From the Allegany oil field only estimates of consumption can be given. Here as in the Pennsylvania oil regions, and even to a greater extent than in some of the Pennsylvania districts, gas is used in drilling and pumping oil wells and at the oil pipe-line pumping stations. During the year 1885, 468 oil wells were completed in the Allegany district, New York. It is estimated that it requires 30 tons of coal on an average to drill a well, so that each well drilled with steam made by gas would displace 30 tons of coal worth say $3.50 a ton or more. In this same district there were 3,677 producing oil wells at the close of 1885; most, if not all, of which were pumped, and chiefly with gas as fuel for making steam. In addition to this, gas is almost the only fuel at the pipe-line pumping stations. One station would consume 10 tons of coal a day. Outside of the Allegany field a portion of the Bradford field is in New York, and to the consumption of gas in oil production and transportation in Allegany must be added that of the portion of the Bradford district in New York, to get the total displacement of coal by gas in that State. To all this must be added the consumption for domestic and manufacturing purposes. As the result of the best information I have been able to secure, it is estimated that the consumption of natural gas produced in New York in 1885 is equal to the displacement of 56,000 tons of coal worth $3.50 a ton, or $196,000.

As is stated elsewhere, the notable high-pressure gas wells of Ohio were not struck in time to bring their production and the consumption of their gas within the limits of time covered by this report. A very much larger amount of gas will be utilized in 1886 than in 1885. It is believed that 50,000 tons will cover the coal displaced by the gas consumed in this State. This may be valued at $2 a ton.

From the best data at hand it is estimated that the coal displaced by gas in West Virginia will not exceed 20,000 tons at $2 a ton.

Though quite a number of natural gas localities are reported from Illinois, the actual consumption was quite small in 1885. From but one place in this State, Litchfield, was any considerable number of consumers reported. From most localities gas enough to supply one family, and in one case as many as four, is all that was reported as actually used. An estimated consumption of gas in 1885 equal to the displacement of 600 tons of coal at a value of $2 a ton is believed to be sufficient to cover all used.

Outside of the localities for which estimates of consumption have already been given, it is believed that 5,000 tons at $4 a ton will cover the coal displaced by gas.

Though considerable difficulty has been experienced in using gas in glass furnaces, it is probable that this difficulty arises not from any want of adaptability of the gas to glass making, but from failure to adapt the furnace to its use. It is evident to the most careless observer that a furnace so constructed as to throw the gas flame or the air draft

sharply against the pots and benches must inevitably ruin them in a very short time. The heat is so intense, and the driving action of the gas gives something in the nature of a blow-pipe flame, which must very soon cut down the pots. The best success in the use of natural gas in glass furnaces has been obtained in flint-glass rather than in window-glass works. In flint-glass furnaces the pots are set around a circular opening through which the flame ascends; in a window-glass furnace the pots are set on the sides of a rectangular oblong furnace. A furnace of this character is not so easily heated as the round flint furnace.

The following statement gives the comparative results of the use of coal and gas at a flint-glass furnace for a year, working with each fuel.

*Cost of fuel (coal) for forty-five weeks in* 1883 *at a flint-glass works at Pittsburgh.*

| | |
|---|---|
| Slack coal | $2,809.78 |
| Coke | 1,288.29 |
| Benzine | 1,584.48 |
| Labor (not needed with gas) | 2,200.00 |
| Total | 7,882.55 |
| Average per week | $175.17 |

*Cost of fuel (gas) for forty-seven weeks in* 1885 *at a flint-glass works at Pittsburgh*

| | |
|---|---|
| Total cost of gas | $4,468.00 |
| Average per week | 94.96 |

Or nearly 46 per cent. less than when working on coal.

The rates charged consumers in Findlay, Ohio, differ somewhat from those charged at Pittsburgh. They are as follows:

| | | | |
|---|---|---|---|
| Cooking-stoves | per month | | $1.00 |
| Sitting-room stoves | do | | 1.50 |
| Grates | do | $2.00 to | 2.50 |
| House lights | do | .15 to | .30 |
| Boilers | and upwards, per year | | 150.00 |
| Patent lime-kilns (draw-kilns) | do | | 100.00 |

### CHARGES TO CONSUMERS FOR GAS.

The charges to consumers for gas vary greatly in different localities, depending usually, in the absence of competition, upon the cost of other fuel at the point of consumption and upon the work for which it is consumed. In the presence of competition, however, no consideration is given to the value of the gas as a fuel or to the value of the other fuel it displaces. Prices are made without the least reference to cost or value. In one instance in the presence of competition in a locality where coal is worth, say, $5 a ton, a company offered to supply gas for cooking and heating stoves at 50 cents a month each. In other cases gas companies have put the fittings into houses and agreed to supply gas for one year free. Such competition is not only ruinous but absurd.

The usual basis of charges for gas is not per 1,000 cubic feet but a given sum per month, or per ton, kiln, pot, or some other unit based upon the product or some apparatus of the industry in which it is used.

In iron making the charge is per ton of iron puddled, heated or rolled; in glass works, per pot of glass melted; in brick making, per 1,000 burned; for steam, per boiler, varying with the size.

It is not necessary to give in detail the rates charged for gas at all points in the country; a few will suffice. The rates of the Philadelphia company at Pittsburgh, which may be taken as fairly representing the ruling rates in that city, are as follows:

*Rates for furnishing natural gas.*

| | | | |
|---|---|---|---|
| Iron and steel: | | | |
| Puddling | long ton | ..... | $1.00 |
| Heating (each heat) | do | $0.40 to | 0.60 |
| Boilers | per month | 50.00 to | 100.00 |
| Total cost of gas per ton iron, single heated | long ton | 1.80 to | 2.10 |
| Sheet iron or steel | do | 2.25 to | 2.60 |
| Hoop iron or steel | do | 2.25 to | 2.60 |
| Open-hearth melting | do | ..... | .70 |
| Crucible steel melting | do | ..... | .50 |
| Hammer furnaces | per day | 1.00 to | 1.60 |
| Glass: | | | |
| Flint, each 10-pot furnace | per month | ..... | 160.00 |
| each large glory hole | do | ..... | 30.00 |
| each small glory hole | do | 15.00 to | 20.00 |
| each lear | do | ..... | 25.00 |
| each steam-boiler | do | 35.00 to | 50.00 |

Average cost of gas about $28 per pot per month.

Window-glass.—Average $33.33 per pot per month, blowing furnaces, flattening ovens, sand furnaces, and boilers included.

Green bottle glass same as window-glass.

Boilers in general works range from $20 to $150 per month.

| | | | |
|---|---|---|---|
| Oil stills | per month | 35.00 to | 100.00 |
| Brick kilns and drying floors | per thousand | ..... | 1.00 |
| Fire brick | do | 1.00 to | 1.40 |

Domestic use.—This is based on the number of square feet heated, the basis being $10 a year for 15 square feet. The charge for heating stoves is $2.50 a month; for open grates, $2.

One or two illustrations as to the relative cost of natural gas and coke in connection with the industries named above may not be without interest. Bituminous coal costs, delivered at the mills in Pittsburgh, from 4½ to 6 cents per bushel of 76 pounds, or from $1.32 to $1.77 per ton of 2,240 pounds.

From 30 to 35 bushels of coal are required to puddle a ton of iron. This, at 5 cents a bushel, would make the cost of fuel for puddling $1.50 to $1.75. The charge for puddling under the tariff of the Philadelphia company, given above, is $1.

To single heat a ton of muck bar for rolling into bar iron requires, say, 15 bushels of coal, which, at 5 cents a bushel, would cost 75 cents a ton for coal as against 40 to 60 cents per ton for gas. In neither case is the coal for making steam included. It is estimated that the entire amount of coal used to make a ton of common bar iron, including steam, heating up furnaces, fuel for puddling and heating is 55 to 60 bushels, which at 5 cents a bushel would make the cost of fuel to a ton of iron, single-heated, $2.75 to $3. The total cost of gas per ton of iron, single-heated, is, as given above, from $1.80 to $2.10, a saving in the cost of fuel of about one-third.

In addition to this there are large economies with gas. There is a large saving in expense in repairs of furnace. There is no expense for removing ashes, which is by no means an inconsiderable amount; there is less waste to the iron when the gas is properly manipulated. It will thus be apparent that the saving in fuel is not the only economy in the use of gas in the Pittsburgh iron mills.

By the use of gas the work in the iron mills is very much less laborious.

The Findlay Gas-Light and Coke Company, which makes the above rates, uses natural gas for illuminating. Regarding the charges and economies in its use, Mr. E. B. Philipp, the superintendent, says:

"A direct comparison between coal gas and natural gas, as to relative cost, may be of interest from a financial standpoint. A dry goods store, the annual coal-gas bills for which amounted to between $400 and $500, now uses natural gas at a cost of $144 per year. A saloon and restaurant with yearly coal-gas bills from $300 to $400 now pays $120 per year. A private residence, with bills formerly at $30 to $35 per year, is now lighted at a cost not exceeding $7 to $8. In making these comparisons the fact must be borne in mind that no meters being used from 50 to 100 per cent. more gas is now consumed than when coal gas was used, metered and sold by the thousand cubic feet. On account of this it is used very lavishly and without regard to economy. Storerooms, where every economy was exercised in the use of coal gas, being only sufficiently lighted for the ordinary wants and requirements of business, are now a blaze of light. Private residences, with formerly a burner here and there, as few as possible, are now brilliant from garret to cellar. The streets, formerly lighted with tips using 4 or 5 feet of gas per hour, on the lamp posts, are now lit up as if the town were illuminated for some special occasion."

### OCCURRENCE OF NATURAL GAS.

A catalogue of the localities in which natural gas had been found was given in the "Mineral Resources" for 1883 and 1884. This catalogue also practically covers all the territory in which natural gas had been found at the close of 1885. It is true there has been some extension of gas fields and areas, but in but few cases could these be called new fields. They were rather extensions of old localities. By reason of this catalogue in the last report it will therefore not be necessary to enter as fully into details as to the localities in which natural gas is found.

In general it may be said that natural gas is found in varying quantities all through the territory from the Hudson river on the east to California on the west. In New York, Pennsylvania, West Virginia, Ohio, Kentucky, Tennessee, Alabama, Louisiana, Indiana, Illinois, Missouri, Iowa, Wisconsin, Kansas, Colorado, Dakota, Utah, Wyoming, and California its existence is reported. The most important fields are those of western Pennsylvania, and Findlay, Ohio.

At the present time, the most important natural gas territory is what is known broadly as the Pittsburgh district of western Pennsylvania, including Murraysville and Grapeville subdistricts in Westmoreland county, the Washington, Cannonsburg, and Hickory subdistricts in Washington county, and Bull Creek subdistrict in Allegheny county. From the wells of these counties in southwestern Pennsylvania the gas territory stretches towards the northeast, following the general trend of the Alleghanies to and into the State of New York. In every county of western Pennsylvania north and east of these, with the exception of Lawrence, Mercer, and Jefferson, gas is found, and it is by no means decided that it will not be discovered in these three. In Beaver, Butler, Armstrong, Indiana, Clarion, Venango, Crawford, Forest, Elk, McKean, Warren, and Erie counties gas is found either in gas wells separate and distinct from oil wells or in connection with them.

The most important of these western Pennsylvania fields is the Murraysville; it is situated some 18 miles east of Pittsburgh, on the western edge of Westmoreland county. On a narrow strip of territory, about 5 miles long, over 30 wells have been drilled without a single failure. The first of these wells, Haymaker No. 1, was put down in 1878, and for 5 years its product was allowed to go to waste. In 1883 other wells were drilled and pipe lines were laid to East Liberty and Pittsburgh, which mark the beginning of the present extensive use of natural gas in that city.

Southeast of Murraysville, near Greensburgh, is the Grapeville district, which at the close of 1885 had very little importance as a gas-producing district, but which has since assumed very extensive proportions. The gas from this is chiefly used in Greensburgh and Johnstown.

The Homewood district lies within the limits of the city of Pittsburgh. The first well was struck here by Mr. George Westinghouse, jr., in May, 1884, and gave promise of an immense yield. In experimenting to shut off the salt water the volume of gas decreased, and the record of the well as a producer has ever since been very unsatisfactory. Some fourteen holes have been drilled in this locality, though but few of them appear to be profitable producers.

In Washington county there are several fields. In the Hickory district the first well, known as the McGuigan, was struck in March, 1882. The gas was allowed to waste for more than a year when a 6-inch main was laid to Birmingham, a part of Pittsburgh, situated on the south side of the Monongahela. The line was 22 miles long. In 1884 two other wells were struck and later two more. The supply from these four wells is enormous. A second portion of the Washington county field is the Cannonsburgh. Some five wells had been drilled at the close of 1885, and others were in progress. In the town of Washington five gas wells have been drilled. These supply the town with fuel, and have not as yet been piped to Pittsburgh. The gas from the wells of the Hickory, McGuigan, and Cannonsburgh districts, all lying a little northwest of Washington, have been piped to Pittsburgh.

In Beaver county, lying northwest of Pittsburgh, what is known as the Bridgewater field has given the best show of gas. It was opened in 1884. Philipsburgh, Beaver, Rochester, New Brighton, and Beaver Falls are supplied with gas from this district.

Returning to Allegheny county, and going north from Pittsburgh up the Allegheny river, there is what is known as the Bull Creek district, which was first tapped by the well of Graff, Bennett & Co., in June, 1878. Over 20 wells have been drilled in this district, considerable of the gas from which is used in manufacturing establishments at Natrona, Tarentum, and Creighton. The Philadelphia company is also piping large quantities to Pittsburgh, about 22 miles.

Still farther to the north from this field is the Lardentown or Harvey field, supplying the works of Spang, Chalfant & Co., at Etna, to which reference has already been made. The old Harvey well has ceased to be a producer, having been drowned out with water. Twelve additional wells have been drilled, seven of which have been abandoned, leaving five connected with a pipe supplying Etna. These five wells together are probably not furnishing as much gas as the Harvey well itself produced ten years ago. At Saxon City, in Butler county, there is a well that has been utilized for making lampblack, while in the neighborhood of Butler, the Burns, Delamater, and other wells have been sunk. The gas from these is used in Butler and the vicinity, and will soon be utilized also at Shields plate-glass works, in process of erection. In Armstrong county there are several localities; at Leechburg, already noted, at Freeport and Apollo, which may be regarded as the same locality, some 12 wells have been put down, but they are all of moderate capacity. Two or three wells just north of Kittanning furnish that town with heat and light, and other wells three miles west, in Franklin township, furnish the gas for the Kittanning Rolling Mill company. At Stewardson Furnace, in the northern part of the county, is a well, the gas from which is being made into coke for manufacture into electric light carbons and other purposes.

The most easterly gas-producing locality in Pennsylvania is at Shingle House post-office, in Sharon township, the extreme northwestern township of Potter county. Gas is also found at several other places in the northwestern portion of this county.

Going westward, along the border of New York, we come to what is known as the Bradford oil district, which has been very prolific in gas. Regarding the gas of this locality, Professor Carll states: "Unrestricted consumption and waste have very materially reduced its pressure and volume. At first the town of Bradford had an ample supply from wells near the city and on the northwestern edge of the oil field; but when this failed, pipes were run to the Rixford gas pool, which reinforced the supply for some time. Later, however, it became necessary to lay a new line, of over twenty miles, to connect with the Wilcox gas pool near the southern line of McKean county, where there is a

large deposit, capable no doubt of responding to all demands that can be made upon it for many years to come. The Wilcox wells have also produced some oil in what is considered to be the equivalent of the Bradford sand; but not enough to make them remunerative as oil wells. The oil sand lies here about 20 feet below ocean level, and more than 400 feet lower than at Bradford."

Gas has been found in considerable quantities in Elk county, at Johnsonburg station, Ridgeway, Kane City, Wetmore, and the Roy and Archer gas pool. At Kane City and at Wetmore an abundance of gas can be had for drilling, and Professor Carll states that even in this region of forests it is found cheaper to use gas than wood for fuel. On the border of Warren and McKean counties is one of the most prolific gas pools in the county, known as the Sheffield. This well has a remarkable history on account of the trouble encountered by the formation of ice in the hole. Regarding some experience with these wells Professor Carll makes the following statement: "After the two-inch tubing had been put in to test the well for oil, it was partly filled with water to buoy up the sucker-rods while being inserted and to lighten the labor of putting them in. When about two-thirds of the rods had been lowered some obstruction was met, and, after ineffectual attempts to force them further, it was concluded that the tubing was imperfect and would have to be withdrawn. Preparations were made to pull the rods, but on attempting to run them up, they were found to be immovable; hence rods and tubing had to be taken out together, a very difficult and undesirable task. When the lower joints of sucker-rods and working-valves were reached, they were seen to be solidly frozen in the tubing. The water at and near the point where gas came into the well had frozen, the ice-core stopped the rods in their downward passage, and, while endeavoring to force the obstruction, new ice set around the valves and rods and held them firmly. These phenomena were considered remarkable at the time, but since then several wells in the Cooper district have been in like manner seriously embarrassed by ice both in drilling and sand-pumping."

It is impossible to give in detail a statement of all the gas localities in Pennsylvania. In the city of Erie a large number of wells have been drilled; in the Venango oil district many large gas wells have been found, and the same is true of Clarion. In Jefferson county, near Brookville, wells of some capacity have been struck, supplying a small amount for heating and lighting purposes, while in Indiana county the gas from the Snyder well, struck in 1883, is piped about 5 miles to Punxsutawney. In the western part of Butler county, near Harrisville and Centreville, gas is found, which is being piped to New Castle and Youngstown, Ohio.

Professor Lesley's conclusions as to where natural gas is likely to be found in Pennsylvania are of interest. In answering the question, Shall I bore for gas at my works? Professor Lesley says:

"First of all, there can be no gas stored up in the oldest rocks. This at once settles the question in the negative for the whole southeastern

third of Pennsylvania. To bore for gas in Bucks, Montgomery, Philadelphia, Delaware, Chester, Lancaster, York, or Adams counties would be simply absurd.

"Second. There can be no gas left under ground where the old rocks have been turned up on edge and overturned, fractured and recemented, faulted and disturbed in a thousand ways. If there ever was any it has long since found innumerable ways of escape into the atmosphere. This settles the question in the negative for all the counties of the great valley—Northampton, Lehigh, Berks, Lebanon, Dauphin, Cumberland, and Franklin—as any one can see by looking at the present condition of their limestone, slate, and sandstone formations.

"Third. There is not the least chance that any gas is left under ground in the greatly folded, faulted, crushed, and hardened formations of the middle belt of the State—Carbon, Schuylkill, Lehigh, Luzerne, Columbia, Montour, Northumberland, Union, Snyder, Lycoming, Perry, Juniata, Mifflin, Centre, Clinton, Huntingdon, Blair, Bedford, and Fulton. Where the oil and gas rocks rise to the surface in these counties, as they do in a thousand places, they show that all their oil and gas have escaped long ago.

"Fourth. Where the rock formations lie approximately horizontal and have remained nearly undisturbed over extensive areas, as in Wayne and Susquehanna, parts of Pike and Lackawanna, Wyoming, Bradford, Tioga, Potter, and all the counties west of the Alleghany mountains, there is always a chance of finding gas (if not oil) at some depth beneath the surface determined by the particular formation which appears at the surface; but as yet we have no satisfactory evidence of the existence of quantities of rock gas in any of these counties east of Potter.

"Fifth. Wherever the bituminous coal beds have been changed into anthracite or semi-bituminous coal it is reasonable to suppose that the same agency which produced the change, whatever it was, must have acted upon the whole column of formations including any possible gas rock at any depth.

"Sixth. Wherever rock oil has been found there and in the surrounding region rock gas is sure to exist."

In the northwestern portion of Allegany county, near the border line of Pennsylvania, is situated what is known as the Allegany oil field. In connection with the oil there is produced an immense amount of gas, which is utilized throughout the field under boilers for raising steam for drilling and pumping wells, and also for domestic purposes. It is also, in addition, piped outside of the oil field proper to Olean, Cuba, Friendship, and other localities in New York, and used for heating, lighting, cooking, and manufacturing. Some little gas is also produced at the oil wells in the northern part of the Bradford field, which reaches over into the southeastern portion of Cattaraugus county.

Gas has also been discovered at West Bloomfield, and even as far east as along the Hudson river, but none of the localities in New York

had developed any commercial importance at the date of this report other than those in the three western counties named, Chautauqua, Cattaraugus, and Allegany.

In Ohio the most important gas field is the Findlay, situated in Hancock county, in the northwestern part of the State. There have been surface indications of natural gas in this county from its earliest settlement, and it has been utilized in a small way for more than forty years. In 1884 a company was organized to drill for natural gas, and in November of that year the Findlay Natural-Gas Company struck gas in the limestone rock at a depth of 1,100 feet below the surface. In 1885 this company put down a second gas well, and a third and fourth well were put down the same year. The most important of the eleven wells yielding gas in this district was finished about January 20, 1886. The measured flow of this well is more than 12,000,000 cubic feet daily.

Due north from the Findlay field, at Bowling Green, in Wood county, is another locality, drilling having begun here in February, 1885. At Fremont, in Sandusky county, a well was drilled in the summer of 1885, gas being found in small amount, the first well yielding, a month after it was completed, less than 10,000 cubic feet. The gas is adapted to domestic use, but the wells lack the force and vigor necessary for a manufacturing supply. At many other towns in the western half of Ohio, inspired by the success in obtaining gas at Findlay and oil at Lima, many wells have been put down, a number of which have turned out dry and others are alleged to be unsuccessful, and in a large number oil and gas have been found. The producing ones, however, have yielded but a few hundred or thousand feet of gas per day.

In the upper Ohio valley, at East Liverpool, the utilization of natural gas began in 1874, gas having been discovered in boring for salt water as early as 1859 and 1860. The supply is very moderate at the present time. Quite a number of wells have been bored, the largest of which is yielding but 35,000 cubic feet per day, and others falling as low as 10,000 cubic feet.

In the same section as the East Liverpool wells, that is, in the upper Ohio valley, is what is known as the Wellsburg gas field. This embraces territory on both sides of the river, in West Virginia and Ohio, but the center of production is at or near Wellsburg, though wells have been drilled as far north as Steubenville and south to Wheeling and Bellaire. More than 50 wells have been put down in this territory within the last three years. The first, known as the Barclay well No. 1, was drilled in December, 1882, and yielded in July, 1885, 30,620 cubic feet of gas a day. A second well, drilled near, in April, 1883, known as Barclay No. 2, was also a vigorous producer, yielding in July, 1885, 469,000 cubic feet a day. The entire supply of this district, however, is reported as decreasing.

The Neff wells are referred to elsewhere. These were bored for oil twenty years ago. Two of the wells have become widely known as large gas producers.

The first well bored in the Macksburg oil field in 1877 yielded dry gas, though this locality is chiefly valuable as an oil field.

It is impossible to mention in detail the localities in this State in which gas has been produced. It is almost impossible to put down the drill anywhere in this State without finding gas in greater or less quantities. Outside of the localities, however, in which the Berea grit and the Trenton limestone have been found the gas is produced in very small quantities. In the Ohio shales a daily yield of 80,000 feet is the highest reported, while wells of one-fourth of this production are counted good, and many range only from 1,000 to 5,000 cubic feet per day.

In West Virginia the important gas fields are those of New Cumberland, on the opposite side of the Ohio river from East Liverpool, and of Wellsburg. There are promising fields in the Kanawha valley also, but they have but little commercial importance at present.

Gas has been found in Illinois in the following counties: Champaign, La Salle, Bureau, Livingston, McLean, De Witt, Macon, Coles, Clark, Montgomery, and Madison, having been first discovered at Champaign in 1853. One field of some importance, and several others that may possibly prove so, have been developed in this State. The most important wells are at Urbana, Champaign county; Mendota, La Salle county; and Litchfield, Montgomery county. The Illinois wells, as compared with the great wells in Pennsylvania, are shallow, occurring for the most part in drift, and though some have yielded gas for years, they they are gradually giving out.

The well at Litchfield, in Montgomery county, is the only one in the State at which gas and oil have been found under geological conditions similar to those of the Pennsylvania wells. At Litchfield, gas and oil are found at a depth of about 650 feet, below the Lower Coal Measures, bordering on the Devonian. Gas was first discovered at this place in 1882, but was not piped into Litchfield until the fall of 1885. The Litchfield well is the only one from which gas has been piped for public consumption, some 4 miles of pipe being laid. The gas now furnished the town is from two wells, drilled in the fall and winter of 1885. The wells, which are situated 2 miles from the town, are in the vicinity of a large gas well struck three years ago, the pressure of which was between 400 and 450 pounds to the square inch. This well was spoiled by salt water about a year ago. The well was drilled dry, and cased at 580 feet, with no salt water found in the gas sand; but after drilling down 200 feet further a heavy vein of salt water was struck. This could not be successfully plugged off, and finally drenched out the gas, which was reached at 640 feet. The present wells have a pressure of about 125 pounds. The country has never been tested to the south, but in May a well was reported as drilling about a mile south of first developments. The country developed is prairie, while towards the south and east it is rough and broken.

At Clinton, in De Witt county, several water wells furnish gas at intervals. Near Hallsville post-office, in the same county, gas has been found. It was utilized for several months, when the well was ruined by sand in the drift. At Decatur and vicinity, in Macon county, where gas is found in the drift and rising in the springs and from the bed of the Sangamon river, its flow has been destroyed in the same way. At Mount Zion, 12 miles east of Decatur, gas has been found in a water well and is still flowing. At Westfield, in Clark county, gas and oil were found in limited quantities some years ago, their first discovery dating back twenty-five years. In Champaign county a score or more of wells in the drift, averaging 100 feet in depth, have been utilized for some years, though there are no deep borings.

About 1871 gas was struck some 3 miles north of Edwardsville, Madison county, at a depth of 90 feet. The pressure of the gas was quite strong, when lighted making a flame 50 feet high. The well was piped, but soon plugged up, in which condition it remains at present.

At several localities in Kansas gas has been found in sufficient quantities to use for heat and light, especially at Paola and Fort Scott. In 1882 a company was formed to drill for oil in Miami county, near Paola, and at a depth of 325 feet struck gas with 50 pounds pressure. The experience and funds were limited, and for some reason the well was neglected, only being used in heating and lighting the house on the farm on which it was found. In the fall of 1885 the county decided to test the practicability of bringing it into Paola, and laid a 3½-inch pipe about 7 miles. It proved a complete success. About the middle of July, 1886, another well was sunk and struck the gas at the same depth. The quality and pressure were found to equal if not excel those of the first well. In the mean time some fifty or more families have used it for fuel and light,and also several manufacturing establishments, and it is expected that its use will soon be universal, as there is from these two wells gas enough for Paola, with 4,000 inhabitants, and many manufactories that may want it, while it is believed that a greater abundance may be had by drilling. Many shallow wells in the county, dug for house use, have gas in greater or less quantities.

Three wells have been put down one mile northwest of Fort Scott, two of which proved successful, gas being found at a depth of from 195 to 200 feet. At the third no gas was found. More wells are reported as drilling.

It is reported that in August, 1885, in Sully county, Dakota, some 30 miles from the Missouri river, natural gas was liberated in a well which was being sunk for water. The gas was found in a vein of gravel 5 feet thick and 140 feet below the surface, the pressure being so great as to send up gravel from the bottom of the vein. The gas when lighted showed a blue-green flame, but would only burn when a hot iron rod or burning brand was held over the escape-pipe. The flame reached about 5 feet in height.

For information relative to other fields, reference should be made to the report for 1883 and 1884.

### HISTORY OF THE USE OF NATURAL GAS IN THE UNITED STATES.

The earliest economic use of natural gas in this country was probably in lighting the village of Fredonia, Chautauqua county, New York, in 1821. For many years prior to this, even as early as the date of the survey of the Holland Land Company, gas had been observed issuing from the crevices of the slate rocks along the banks of the Canadaway creek, on which Fredonia is built. In 1821 a well, 1½ inches in diameter and 27 feet deep, was put down near the Main street bridge which crosses this creek; this was probably the first well sunk for the purpose of obtaining natural gas. This well produced gas sufficient for some 30 burners, the burner being made by drilling a hole, the size of a small knitting needle, in a pipe. The light from one of these "burners" was regarded as equal to that of "two good candles;" gas of 2-candle power would hardly answer the demand of to-day. The gas was conveyed from the well to the buildings in which it was used in wooden pipes. In 1824, on the occasion of Lafayette's visit, the village was lighted with natural gas.

In 1825 a small gasometer was put in and the wooden pipes replaced with lead ones, which so improved the conditions that the Fredonia "Censor" of December, 1825 says: "We witnessed last evening the burning of 66 beautiful, clear gas-lights, and 150 lights could be supplied from this gasometer. There is now sufficient gas to supply another one as large."

The existence and utilization of this gas at Fredonia became widely known, both in this country and abroad, and excited the liveliest interest among scientific men, but so little suspected was the presence of the enormous volume of gas since developed that it was pronounced "unparalleled on the face of the globe," and Humboldt is quoted as declaring it the eighth wonder of the world.

This well of 1821, which was afterwards drilled to the depth of 70 feet into the black shales of the Marcellus beds, was the only one producing gas in the village until 1858, though another well was sunk in 1850. It yielded water as well as gas and required constant pumping, the gas not having pressure enough to force itself through the water. This well was in uninterrupted use until 1885, when some repairs to Tefft's mill, adjoining, made it necessary to tear away the pumping machinery. The product of gas is but a trifle less than when it was first completed, 65 years ago.

In 1859 a well of a peculiar character was sunk, or rather the second well, that of 1850, was enlarged. A shaft 30 feet deep, 6 feet in diameter at the top and 14 feet at the bottom, was dug. From the bottom, lateral and two vertical borings, one 100 feet deep, the other 150 feet, were put down. A production of 4,500 feet of gas a day was secured,

supplying 200 burners. In 1871 a still larger well was bored to the depth of 1,200 feet. In 1885 the total yield of these wells was 6,000,000 cubic feet.

Shortly after gas was found at Fredonia, Judge Campbell, of Westfield, New York, used natural gas from a spring near by for the light-house at Barcelona, a small harbor on Lake Erie. The contract was abandoned in 1856, though the gas is still used, supplying all the churches, public halls, schools, and about twenty families. In 1827 a contract was made by Walter Smith, of Dunkirk, New York, with the Government to supply the light-house at that place for a term of years, and a ½-inch lead pipe was laid 2½ miles from the Matteson gas spring at Fredonia, but, owing to the size of the pipe, no flow was obtained, and after many trials of other means of transportation the enterprise was abandoned.

The existence of marsh gas, the modern natural gas, was well known to the earliest explorers of the Kanawha valley. In 1775 Washington, while on a visit to the Kanawha to locate lands granted him for his military services, set apart and deeded to the public forever a square acre of land in which was located a "burning spring." Through some informality his intention in this gift was frustrated. The "burning spring" mentioned by Mr. Jefferson in his "Notes on Virginia" was probably this same spring.

The boring for salt water in the Kanawha valley, which was begun in the winter of 1807–'8, not only resulted in finding brine, but nearly every salt well became a gas well, the gas in many cases jetting the water into the air and taking fire. From wells only 15 to 20 feet deep the gas escaped in quantities, burning a long time. As early as 1815 a gas well was struck within the present city limits of Charleston. This well was bored for salt, and upon striking the gas reservoir it gave out a great volume of gas, which caught fire from a grate near at hand. The gentlemen boring the well conceived that it would be reckless to bore deeper, and abandoned the well, which afterwards passed into the possession of the Charleston Gas-Light Company.

It is worthy of notice that many of the methods and appliances that have made deep well boring possible were developed and perfected at these salt gas wells. The chisel-bit, the "jar," sectional tubing, made then of tin and soldering, instead, as now, of iron with screw joints, the "seed bag," were all used at the Kanawha Valley salt wells before oil was found in western Pennsylvania.

So far as has been ascertained the first use of natural gas in manufacturing was in "boiling salt," in the Kanawha valley of West Virginia, by William Tompkins, in 1841, some twenty years after its use for lighting at Fredonia, New York. While boring a well for salt a short distance up the Kanawha river from the "burning spring," above alluded to, he struck a large and steady flow of gas, which was strong enough to force the salt water into a reservoir from which it could be distrib-

uted to his furnace pans. He determined to use this gas as a fuel to "boil his furnace," and for this purpose extemporized a gasometer from a hogshead placed over the reservoir. Into this primitive receptable he carried the escaping water and gas, the water falling into the reservoir. The gas conveyed through a pipe to the mouth of his furnace, a "salt block" 100 feet long by 6 deep and 4 wide, produced an intense heat under the whole row of kettles.

In 1843 gas was struck, in a well bored near Tompkins's, at the depth of 1,000 feet. The force of the gas was so great as to throw a column of salt water 150 feet above the mouth of the well. This is the first "gasser" and "roarer" on record.

From the beginning of the drilling of oil wells in Pennsylvania in 1859 natural gas has been obtained in greater or less quantities, either accompanying the oil or in wells that were true gas wells, that is, yielding little or no oil. In most of the flowing oil wells the pressure which forces up the oil is this gas. The attention of oil producers was first directed to the danger connected with this gas by the explosion of the Rouse well in Oil creek, one of the first flowing wells struck. Eighteen persons lost their lives by the explosion of gas at this well.

At first this gas was considered not only of no value, but a dangerous nuisance, and was carefully led away from the wells in pipes and burned to get rid of it. After a little, however, it began to be used for fuel under the boilers in drilling and pumping and for light and fuel in the towns and villages in the immediate vicinity of the wells. The proportion of the gas so used, however, until some two years since, was very small. The apparatus for collecting this gas for use in raising steam in drilling was at first quite simple. The oil and gas as they came from the well were led in a barrel or hogshead, the oil being drawn off by a pipe at the bottom and the gas by a pipe at the top.

The so-called Leechburg gas well, the gas from which was the first used in iron making, was bored for oil in 1870 and 1871, the gas vein being struck in the latter year, at a depth of 1,200 feet. This well is situated on the south side of the Kiskiminetas river, in Armstrong county, Pennsylvania, opposite Leechburg. For some months the gas was allowed to escape without any attempt to utilize it, until, in April, 1873, Messrs. Rogers & Burchfield bought the well and piped the gas across the river to their works on the north bank. The gas was accompanied by a large flow of salt water. To separate the gas from the water it was conveyed from the well by a $5\frac{3}{8}$-inch pipe into a common cylindrical boiler, furnished with an ordinary safety valve. The water was drawn off at the bottom of the boiler through a quarter-inch pipe, it being forced out in a spray. From the top of this boiler receiver the gas was led across the river and distributed by a net work of pipes through the mill. As noted above, this was the first use of gas in iron works.

The first gas piped any considerable distance was from what is known as the Harvey well, near Larden's mills, in Butler county, Pennsylvania.

This, at the time it was bored, in the fall of 1874, was the most powerful gas well in the section. In 1875 it was purchased by the Natural Gas Company, limited, the first natural gas company formed, and piped 17 miles, through a 6-inch pipe made of iron $\frac{1}{4}$ inch thick, to the mill of Messrs. Spang, Chalfant & Co., at Etna, near Pittsburgh. The gas was turned into the pipe in October, 1875, and traversed the 17 miles in twenty minutes, the pressure at the wells observed being 119 pounds.

The first use of gas in glass making appears to have been at the Rochester tumbler works, at Rochester, Pennsylvania. The date it has not been possible to learn.

In 1883 Mr. J. B. Ford, at the Pittsburg plate glass works, at Creighton, Pennsylvania, succeeded in securing a supply of gas for his glass works, since which time these works have been run entirely by natural gas, as will also be a new and larger works building near the Pittsburgh plate glass works, and a third one in course of construction at Butler, in the same State.

It was not until 1883, with the piping of the gas of the Murraysville district to Pittsburgh, and the stiking of gas in the Westinghouse well, at Homewood, Pittsburgh, that natural gas began to be used extensively as a fuel. Prior to this time its use had been exceptional and at isolated works, but with the piping of this gas, and the striking of the Westinghouse well, the extension of its use became instant and well nigh universal for manufacturing purposes in the neighborhood of Pittsburgh. Its introduction into the rolling mills of Wilson, Walker & Co. and Shoenberger & Co., and the flint-glass furnace of the Fort Pitt glass works, was rapidly followed by its adoption in other establishments, until now few of the important manufactories of Pittsburgh that are so situated as to obtain a supply of gas cheaply, use any other fuel.

It is unnecessary to follow the history of the use of natural gas in and around Pittsburgh, as it was quite fully detailed in the article on natural gas published in "Mineral Resources" for 1883–'84.

Gas first began to be utilized in manufacturing in Erie, Pennsylvania, about 1868, by the Jarecki Manufacturing Company. The first well was put down some 600 feet, and yielded largely at first, but the amount steadily decreased. This has been the history of all the wells in this region, the pressure at some being at first as much as 50 pounds to the square inch, but rapidly falling off and becoming extremely irregular. At the Erie furnace of Messrs. Rawle, Noble & Co. an attempt was made in 1874 to use natural gas in a blast furnace. This gas was from a well 800 feet deep, with a pressure of 25 pounds. It was driven into the furnace by its own pressure, through a $\frac{3}{4}$-inch pipe inserted in the tuyeres. Its use was not a success.

In Ohio the first use of natural gas appears to have been for domestic purposes at Findlay. Natural gas had been known to exist in this place from its first settlement, and was met with in digging cellars, wells, and sewers, and in springs and rock crevices. Explosions in excavations

were by no means infrequent. The gas collected from a well dug for water was introduced into a house in Main street in 1838, and has been burning ever since. Some sixteen years ago Gen. J. S. Casement drilled a well at Painesville, which yields enough gas for ordinary household use.

The first discovery of natural gas in the neighborhood of East Liverpool, Ohio, a locality noted for its manufacture of pottery, was in 1860, while drilling for oil. Gas was found at several places in the vicinity about the same time. At Jethro, a locality within the town limits of East Liverpool, two gas wells were struck; also one on Ball's island, in the Ohio river, opposite the east end of the town; one on McKinnon farm, east of the Cleveland railroad depot; one on the Virginia shore directly across the river from this depot, and several others of but little note. The gas was struck at 400 to 600 feet from the surface.

The Jethro well produced strong salt water in abundance, which was thrown out in large volume by the pressure of the gas. A short time after the well was struck, evaporating pans were put up and the gas utilized in evaporating salt water, which was also thrown out of the well by its pressure. Shortly after this utilization of the gas at the Jethro well, the gas from another well, at Little Beaver bridge, 4 miles east of East Liverpool and near the Pennsylvania State line, was utilized in the same way. It appears from this, therefore, that as early as 1860 natural gas was used in evaporating salt in the East Liverpool district.

In October, 1873, Mr. Homer Laughlin sunk a well at his pottery, within the town limits, this being the first well bored especially for natural gas. Its product was also the first gas utilized in the East Liverpool region for fuel and light, with the exception of the gas from the two wells above mentioned, which was utilized in salt manufacture. Two years later, or in 1875, other parties in East Liverpool bored wells, the gas from which was also used for fuel and light.

These wells, however, have never been large producers, and have only furnished gas for light and fuel for small fires. Some years ago, at a time when a number of wells had been freshly bored, the gas from them was used in firing a very few kilns of pottery, a large number of the best wells, owned by different parties, being coupled or connected together.

The supplies from these old wells have been gradually falling off, until at present the entire product will only furnish gas sufficient for light and fuel for a few stoves and house fires. Recently, however, a very productive gas territory has been opened some 6 miles south of East Liverpool, in West Virginia, the gas from which has just been piped to this town, and is being used in the potteries for all purposes for fuel and light. At the present time it is the only fuel used in these establishments.

### NATURAL GAS AS AN ILLUMINANT.

As has already been stated, the first use of natural gas was as an illuminant at Fredonia, New York, and yet, as indicated by analysis and practical tests, it is, under the ordinary methods of use, a heating rather than an illuminating gas. The illuminating hydrocarbons are either low or wanting. There is occasionally a little olefiant gas, rarely exceeding 1 per cent. of the total. These illuminants are so small a proportion, therefore, that they can be ignored in discussing its value for lighting purposes. The gas, as has been shown, can be regarded as chiefly marsh gas and hydrogen. The hydrogen flame is a heating flame, bluish white, and giving intense heat, but very little light. The marsh gas is also high in heating power, but burns with a yellowish flame, giving much more light than the hydrogen. It will be evident, therefore, that as the proportion of these two elements varies, so will the lighting power, under ordinary conditions of burning, vary—the more hydrogen, the less light.

And yet, as a rule, the lighting power of natural gas is by no means low, though lower than the coal gas usually furnished to consumers. The candle power of the natural gas of the Pittsburgh district is usually given as 8 candle power; of the Findlay, Ohio, from 12 to 14, and of the Mendota, Illinois, as "about 12."

The most careful and interesting experiments that have been made in the use of natural gas as an illuminant have been made at Findlay, Ohio, under the direction of Mr. E. B. Philipp, superintendent. The results of these experiments, briefly stated, are that the best form of burner for natural gas, as for coal gas, is the argand. With a 36-hole lava tip argand burner, an accurate corrected candle power of 12.57 was obtained. Where a flat flame was desired various flat-flame Bray burners were used, which gave a corrected candle power of 10.85. A special bat's-wing burner made by the American Meter Company gave a corrected candle power of 11.57. These tests were made with the crude gas, but by partially purifying it by passing it through lime boxes, removing the carbonic acid and sulphureted hydrogen, the candle power was increased to 13.77. Mr. Philipp, writing regarding the results obtained and the cost of gas for illumination at Findlay, says:

"The best general results are obtained in using burners consuming from 8 to 9 cubic feet per hour. When burned thus it gives a good, satisfactory light, excelling in a number of instances some qualities of coal gas.

"Summing up our entire experience in the matter, we must admit that, contrary to our expectations, contrary to what we considered in the beginning good judgment, we shall continue to furnish natural gas as an illuminant as long as it lasts, and can say that natural gas, so far as Findlay is concerned, and so far as any other locality may be concerned where the gas is similar to the Findlay gas, will most undoubtedly become an active competitor of coal gas, as it can be metered at a

good profit at less price per thousand than it now costs for the mere distribution of coal gas."

In addition to the argand burners, which seem to have given such good results at Findlay, various forms of regenerative burners have been used, chief among which are the Siemens and the Haupt. The Haupt seems in some respects better adapted to burning natural gas than even the Siemens. These are too well known to need description. Besides these, what is known as the Todd burner has given most excellent results. This burner is constructed on the principle that there is not enough carbon in the gas to give sufficient illumination under ordinary methods of burning; hence the air, before it comes in contact with the gas, is heated to a very high degree, and, striking the gas, burns the hydrogen at once and makes the carbon incandescent. The air is heated by passing through three saucer-shaped perforated steel plates, placed concentrically, attached at the rims, but separate elsewhere through their outer and inner surface, and so arranged that the perforations in two consecutive plates are not opposite each other. This is attached to the gas service pipe immediately under the burner, which is simply a cap placed on top of the service pipe, the pipe having holes drilled immediately under this cap. The flame plays around the cap like the flame of an argand burner, and heats the steel plates, through which the air passes immediately beneath it. Of course the air passing through the small perforations of the steel regenerator is split up and highly heated.

### PRESSURE AND PRODUCTION OF WELLS.

Until quite recently the published figures of the pressure and production of gas have been largely estimates, usually based upon no accurate measurements. Even when there have been observations and measurements, no uniform system has been adopted, so that, though a statement as to the pressure or production of a given well may be a fairly correct approximation as to that well under the conditions of the test, yet a comparison of the results at this well with those from another one, made under different conditions, would be without the least value.

Most of the statements as to production are the results of calculations of but little value, based upon an observed or calculated pressure of a well when closed for a given time. Early in the history of natural gas wells of high pressure, it was observed that if the well was closed it rapidly accumulated pressure, in some cases the gauge showing a pressure so great that it was not deemed wise to keep the well closed. It is doubtful, however, if maximum closed pressure of 1,000 pounds per square inch has yet been found. It will also be evident that as the flow of gas for consumption is not under closed pressure, but open pressure, any calculations as to production based upon this closed pressure must be erroneous.

The Ohio Geological Survey, under the direction of Professor Orton, has devoted considerable attention to the problem of gas pressure and production, and has secured the best results thus far obtained.

Two methods have been adopted—the anemometer for small wells yielding 1,000,000 cubic feet or less a day, and a modification of Pitot's tubes for larger wells. The use of the anemometer for this purpose was first suggested, so far as is known, by Mr. E. McMillon, of the Columbus, Ohio, Gas-Light Company, and was first used in measuring the Adams well, at Findlay, in June, 1885. The measurements obtained have been compared with those obtained by other methods, and their reliability established.

The use of the modified form of Pitot's tubes was devised and worked out by Prof. S. W. Robinson, of the Ohio State university. A complete statement regarding this use will be found in Van Nostrand's Magazine for August, 1886.

The most carefully observed pressures and productions have been made in Ohio. In the Findlay field the actual product of wells varies from 80,000 cubic feet, at the Adams well, to 12,080,000 cubic feet, at the Karg well. The closed pressure at the wells of this district is about 375 pounds to the square inch. In the first wells it registered 450 pounds. In none does the limit now exceed 400. It has been found that all wells of a district great and small attain finally the same pressure, some reaching the maximum or average pressure sooner than others. The Karg well in the Findlay district reaches it in 1½ minutes; the smaller ones may require hours. The actually observed daily production of four wells in this district, as given by Professor Orton, are as follows:

| | *Cubic feet.* |
|---|---|
| Karg well | 12,080,000 |
| Cory well | 3,318,000 |
| Briggs well | 2,565,000 |
| Jones well | 1,159,200 |

No accurate statements of production and pressure of Pennsylvania wells have been obtained. The estimated production of some of the "gassers" of the Murraysville district is 30,000,000 cubic feet a day. The partially open pressure in this district is from 150 to 200 pounds. In the Wilcox district the closed pressure reaches 575 pounds and there remains stationary. In some parts of Butler county it is 250 pounds.

In Allegany county, New York, the closed pressure is 450 pounds.

In Illinois a pressure of 400 to 450 pounds is reported at the Litchfield wells when first drilled, but this has been reduced to 125 pounds. At Urbana the pressure at one well is but 10 pounds; at a second, 25 pounds.

### THE STORAGE OF GAS.

The waste of gas, especially in western Pennsylvania and in the Ohio fields, in which high-pressure gas is found, has been simply enormous, the amount reaching a total so marvelous that it is impossible to form

any accurate conception of it. It is estimated, for example, that the waste of gas at the Haymaker well No. 1, the first struck in the Murraysville district, during the five years when it was not used, was the equivalent of 1,000 tons of coal a day. The Harvey well, the gas from which was piped to Spang, Chalfant & Co.'s in 1875, blew millions of feet of this valuable fuel into the air before it was utilized, and the gas from the McGuigan well in the Washington County district of western Pennsylvania was not used for over a year after it was struck.

Various methods have been suggested for storing the gas. As oil was stored in tanks, it was very natural that tanks should be suggested, but such a suggestion could only have come from those unacquainted with the enormous pressure and volume of gas from great wells. This system was, of course, applicable where the production was very small and the pressure limited, as in the case of the shale gas in Ohio; but where the greatest waste is—that is, in western Pennsylvania and parts of Ohio—the suggestion is simply absurd.

It was also very natural to seek to confine the high-pressure gas by placing caps with gates upon the top of the well casing, but it was found in many instances that the pressure rapidly accumulated to a point where there was danger of blowing the casing out of the well, and this system was temporarily abandoned.

Two methods have been adopted recently for storing gas; one adapted to territory where the prospect of obtaining gas by drilling is reasonably certain, and the other applicable to all wells of ordinary pressure. The first consists simply in drilling as near as possible to the depth at which the gas reservoir is supposed to be, and then "holding the well," as it is termed, and bringing it in by drilling a little deeper whenever the demand for gas or the decrease in other wells requires it. Recently, however, a method of storage by packing the wells has been adopted. This confines or stores the gas in its own reservoirs. The packer most largely in use is the same that is used in oil wells, only in putting the packer together for gas wells it is necessary to use extra precautions to prevent the gas from blowing off the rubber. This is done by fitting the rubber tightly to the inner pipe and wiring the end securely in place. One packer used is a rubber annulus from 8 to 20 inches in length, with an outside diameter half an inch less than the bore of the well. The inside diameter is large enough to permit it to go over the tubing used in the well. The pipe going through the rubber is screwed into a flange at the upper end, the flange being large enough to cover the end of the rubber. Then another flange is slipped over the lower end of the pipe the same size as the rubber, thus making a slip point. The outside of the lower flange is threaded so as to screw on to a sleeve, which is large enough for a coupling to slide in. The coupling is screwed on to the lower end of the pipe going through the rubber. The coupling makes a pipe to engage with the shoulder on the flange which supports the anchor or lower part of the tubing while be-

ing lowered into the well or removed from the well, thus making a telescopic joint. Enough tubing is screwed together before the packer is screwed on to bring the packer as high from the bottom of the well as is desired. Then the packer is screwed on the tubing, then the balance on top of the packer, until the bottom of the well is reached. One joint of the anchor or lower tubing is perforated, to admit the oil or gas into it when the packer is expanded to the wall of the well. When the anchor strikes the bottom of the well the weight of the tubing above the packer comes on the rubber and forces the pipe into the sleeve or telescopic joint and presses the rubber between the two flanges and out to the wall of the well, thus making the oil or gas below the packer go into the tubing at the perforation and thence to the top through the pipe. Of course the casing of the well is anchored down to prevent blowing out. While it may be fairly assumed from the statements and evidence that gas can be retained in a well without wasting, no means as yet seems to have been devised for saving the gas that escapes from the pipes after it has left the well.

### EXHAUSTION OF GAS.

That the supply of gas is limited, and that it ultimately will be exhausted, does not admit of question. In this belief all unite. How long the supply will last is the subject of argument. The advocates of the storage theory assert that the supply will be exhausted when the gas stored in the storage reservoirs is exhausted, while no advocate of the continuous production theory, so far as we are aware, believes that the present rate of outflow can be maintained by any probable rate of production that is at present going on in the earth's interior. The latter theorists of course hold that, as production is continuous, the day of exhaustion is further in the future than is admitted by the advocates of the storage theory, and that even when the vast storehouses are exhausted production will still continue and gas be supplied, but in smaller quantities.

Experience furnishes some information relative to the exhaustion of certain fields, and supplies an imperfect basis of calculation as to the ultimate failure of the supply, but, after all, there are but few data upon which to rest any reasonable prediction. It is found, as a rule, for example, that "shallow wells," whatever may be the pressure or supply when first struck, give out much sooner than what are known as "deep wells." In certain districts the supply at individual wells is soon exhausted, and the amount furnished by new wells when first bored is a constantly decreasing quantity as compared with that supplied by the earlier wells. In other districts the life of wells is longer, but the earlier wells are now quite weak or exhausted, and new wells sunk do not produce any such amount of gas as those at first drilled. In still other districts, however, the great "gassers" at first struck have been

pouring out gas by the million feet per day for years without any apparent diminution in pressure or volume.

Dr. Chance has made a calculation of the amount of gas stored in the rocks underlying western Pennsylvania, which is based upon an assumed proportion of productive to non-productive territory, and an application of this ratio to the Pittsburgh gas region. On the basis of this calculation, estimating the consumption at 600,000,000 cubic feet daily, and the waste at 100,000,000 cubic feet, the gas territory within 30 miles of Pittsburgh would be exhausted in about eight years. This estimate is, of course, a fanciful one, and other conditions might be assumed with some appearance of correctness which would bring the day of exhaustion nearer, while others would carry it farther away. Professor Lesley states, regarding gas areas, that they are evidently small, scattered irregularly, hemmed in by water areas and oil areas, and not absolutely stationary, but shift their position slowly. This shifting, he suggests, will become comparatively rapid as the stock of gas is drawn off in the direction of the working wells, and what was at first a gas field becomes changed to an oil or water field. Professor Lesley also suggests, as a contribution to this question of the exhaustion of wells, a carefully recorded rate of decline in the gauge pressure at each well. To this end automatic self-registering vacuum gauges should be lowered to the bottom of every gas well at regular intervals of time, and records of their readings kept.

# IRON.

## TWENTY-ONE YEARS OF PROGRESS IN THE MANUFACTURE OF IRON AND STEEL IN THE UNITED STATES.

By James M. Swank,
*General Manager American Iron and Steel Association.*

The beginning of the manufacture of Bessemer steel in the United States at Wyandotte, Michigan, late in 1864, and at Troy, New York, early in 1865, marks the opening of a new and remarkable period in the history of our iron and steel industries, the statistical features of which period it is proposed to make the subject of the present paper. As the important metallurgical event referred to was cotemporaneous with the close of the civil war, after which all the industries of the country were compelled to rely upon a normal demand for their products, the propriety of beginning this statistical inquiry with 1865, just twenty-one years ago, is doubly justified. Statistics to be valuable must be comparative, and the longer the period over which they extend the more valuable and suggestive they become. It is preferred to give the record of twenty-one years rather than to dwell entirely upon the statistical results of the last two or three years.

The following table of the production of the leading articles of iron and steel in the United States during the period above-mentioned is compiled from the statistics of the American Iron and Steel Association. In the column devoted to steel rails it will be noticed that no figures are given for 1865 and 1866, the explanation being that steel rails were only made experimentally in these two years. The first Bessemer steel rails ever made in the United States were rolled at the North Chicago rolling mill on the 24th of May, 1865, from ingots made at the experimental steel works at Wyandotte; but the first steel rails ever rolled in this country in the way of regular business, to fill an order, were rolled by the Cambria Iron Company, at Johnstown, in August, 1867, from ingots made at the works of the Pennsylvania Steel Company, at Harrisburg.

*Production of leading articles of iron and steel in the United States from* 1865 *to* 1885.

| Years. | Short tons of 2,000 pounds. | | | | | | |
|---|---|---|---|---|---|---|---|
| | Pig iron. | Rolled iron, including nail plates, but excluding iron rails. | Iron rails. | Steel rails. | Rails of all kinds. | Steel ingots and other steel. | Blooms from pig and scrap iron and iron ore. |
| 1865 | 931, 582 | 500, 048 | 356, 292 | ..... | 356, 292 | 15, 262 | 63, 977 |
| 1866 | 1, 350, 343 | 595, 311 | 430, 778 | ..... | 430, 778 | 18, 973 | 73, 553 |
| 1867 | 1, 461, 626 | 579, 838 | 459, 558 | 2, 550 | 462, 108 | 22, 000 | 73, 073 |
| 1868 | 1, 603. 000 | 598, 286 | 499, 489 | 7, 225 | 506, 714 | 30, 000 | 75, 200 |
| 1869 | 1, 916, 641 | 642, 420 | 583, 936 | 9, 650 | 593, 586 | 35, 000 | 69, 500 |
| 1870 | 1, 865, 000 | 705, 000 | 586, 000 | 34, 000 | 620, 000 | 75, 000 | 62, 259 |
| 1871 | 1, 911, 608 | 710, 000 | 737, 483 | 38, 250 | 775, 733 | 82, 000 | 63, 000 |
| 1872 | 2, 854, 558 | 941, 992 | 905, 930 | 94, 070 | 1, 000, 000 | 160, 108 | 58, 000 |
| 1873 | 2, 868, 278 | 1, 076, 368 | 761, 062 | 129, 015 | 890, 077 | 222, 652 | 62, 564 |
| 1874 | 2, 689, 413 | 1, 110, 147 | 584, 469 | 144, 944 | 729, 413 | 241, 614 | 61, 670 |
| 1875 | 2, 266, 581 | 1, 097, 867 | 501, 649 | 290, 863 | 792, 512 | 436, 575 | 49, 243 |
| 1876 | 2, 093, 236 | 1, 042, 101 | 467, 168 | 412, 461 | 879, 629 | 597, 174 | 44, 628 |
| 1877 | 2, 314, 585 | 1, 144, 219 | 332, 540 | 432, 169 | 764, 709 | 637, 972 | 47, 300 |
| 1878 | 2, 577, 361 | 1, 232, 686 | 322, 890 | 559, 795 | 882, 685 | 819, 814 | 50, 045 |
| 1879 | 3, 070, 875 | 1, 627, 324 | 420, 160 | 693, 113 | 1, 113, 273 | 1, 047, 506 | 62, 353 |
| 1880 | 4, 295, 414 | 1, 838, 906 | 493, 762 | 968, 075 | 1, 461, 837 | 1, 397, 015 | 74, 589 |
| 1881 | 4, 641, 564 | 2, 155, 346 | 488, 581 | 1, 355, 519 | 1, 844, 100 | 1, 778, 912 | 84, 606 |
| 1882 | 5, 178, 122 | 2, 265, 957 | 227, 874 | 1, 460, 920 | 1, 688, 794 | 1, 945, 095 | 91, 293 |
| 1883 | 5, 146, 972 | 2, 283, 920 | 64, 954 | 1, 295, 740 | 1, 360, 694 | 1, 874, 359 | 74, 758 |
| 1884 | 4, 589, 613 | 1, 931, 747 | 25, 560 | 1, 119, 291 | 1, 144, 851 | 1, 736, 985 | 57, 005 |
| 1885 | 4, 529, 869 | 1, 789, 711 | 14, 815 | 1, 079, 400 | 1, 094, 215 | 1, 917, 350 | 41, 700 |

In this table will be found much information that is worthy of thoughtful attention. From 1865 to 1882 our production of pig iron increased from 931,582 tons to 5,178,122 tons. From 1865 to 1883 our production of rolled iron increased from 500,048 tons to 2,283,920 tons. Owing to the substitution of steel rails for iron rails our production of iron rails decreased from 905,930 tons in 1872, the highest aggregate that has ever been reached, to 14,815 tons in 1885. From 1867 to 1882 our production of steel rails increased from 2,550 tons to 1,460,920 tons. From 1865 to 1881 our production of rails of all kinds increased from 356,292 tons to 1,844,100 tons. From 1865 to 1882 our production of steel of all kinds, principally Bessemer steel, increased from 15,262 tons to 1,945,095 tons. These are certainly very remarkable results. No other country can present a record of such rapid growth in its iron and steel industries as is shown in this table. It is true that the figures for very recent years show a shrinkage in all the branches of production enumerated, but it is noticeable that this shrinkage in the United States was in sympathy with a world-wide depression in the manufacture of iron and steel and other staple manufactured products, and it is also noticeable that our iron and steel industries have already rebounded from the depressing influences which decreased their production, although the increase in prices, except in the case of steel rails, has not yet been very marked. The production of pig iron, steel, and steel rails will certainly be larger in 1886 than in 1884 or 1885, and larger than in any year of our history.

The preceding table gives the aggregate production of leading articles of iron and steel in the country at large for the years mentioned. The

production by States and Territories of pig iron, rails, all rolled iron, cut nails, and all kinds of steel for the six years which begin with 1880 will now be presented.

*Pig iron.*—Iron in the form of pig iron has been produced in the last six years in twenty-six States and two Territories. In the early part of this century it was still customary to run the melted iron in the blast furnace directly into stoves and domestic and mechanical castings, as well as into pig iron, but now only pig iron is made at our furnaces, except in connection with a few of our Bessemer steel works, where the product of the furnace is run directly into the Bessemer converters. For statistical purposes this special product may be treated as pig iron. Our production of pig iron in the last six years has been distributed as follows:

*Production of pig iron in the United States, by States and Territories, in the last six years.*

| States and Territories. | Short tons of 2,000 pounds. | | | | | |
|---|---|---|---|---|---|---|
| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
| Maine | 3,578 | 4,400 | 4,100 | 4,400 | ..... | 440 |
| Vermont | 1,800 | 2,796 | 1,210 | ..... | ..... | ..... |
| Massachusetts | 19,017 | 18,318 | 10,335 | 10,760 | 4,902 | 869 |
| Connecticut | 22,583 | 28,483 | 24,342 | 19,976 | 14,174 | 17,500 |
| Total New England States | 46,978 | 53,997 | 39,987 | 35,136 | 19,076 | 18,809 |
| New York | 395,361 | 359,519 | 416,156 | 331,964 | 239,486 | 160,157 |
| New Jersey | 170,049 | 171,672 | 176,805 | 138,773 | 82,935 | 73,667 |
| Pennsylvania | 2,083,121 | 2,190,786 | 2,449,256 | 2,638,891 | 2,385,402 | 2,445,496 |
| Total middle States | 2,648,531 | 2,721,977 | 3,042,217 | 3,109,628 | 2,707,823 | 2,679,320 |
| Maryland | 61,437 | 48,756 | 54,524 | 49,153 | 27,342 | 17,299 |
| Virginia | 29,934 | 83,711 | 87,731 | 152,907 | 157,483 | 163,782 |
| North Carolina | ..... | 800 | 1,150 | ..... | 435 | 1,790 |
| Georgia | 27,321 | 37,404 | 42,440 | 45,364 | 42,655 | 32,924 |
| Alabama | 77,190 | 98,081 | 112,765 | 172,465 | 189,664 | 227,438 |
| Texas | 2,500 | 3,000 | 1,321 | 2,381 | 5,140 | 1,843 |
| West Virginia | 70,338 | 66,409 | 73,220 | 88,398 | 55,231 | 69,067 |
| Kentucky | 57,708 | 45,973 | 66,522 | 54,629 | 45,052 | 37,553 |
| Tennessee | 70,873 | 87,406 | 137,602 | 133,963 | 134,597 | 161,199 |
| Missouri | 105,555 | 109,799 | 113,644 | 103,296 | 60,043 | 51,408 |
| Total southern States | 502,856 | 581,339 | 690,919 | 802,556 | 717,642 | 764,243 |
| Ohio | 674,207 | 710,546 | 698,900 | 679,643 | 567,113 | 553,963 |
| Indiana | 12,500 | 7,300 | 10,000 | 9,950 | 2,568 | 6,634 |
| Illinois | 150,556 | 251,781 | 360,407 | 237,657 | 327,568 | 327,977 |
| Michigan | 154,424 | 187,043 | 210,195 | 173,185 | 172,834 | 143,121 |
| Wisconsin | 96,842 | 102,029 | 85,859 | 51,893 | 52,815 | 24,622 |
| Minnesota | 3,520 | 7,442 | 8,126 | 8,000 | ..... | ..... |
| Total western States | 1,092,049 | 1,266,141 | 1,373,487 | 1,160,328 | 1,122,898 | 1,056,327 |
| Colorado | ..... | 6,396 | 23,718 | 24,680 | 15,837 | 5,481 |
| Utah Territory | ..... | ..... | 57 | ..... | ..... | ..... |
| Oregon | 5,000 | 6,100 | 6,750 | 7,000 | 3,640 | 3,832 |
| California | ..... | 4,414 | 987 | 5,327 | 2,157 | ..... |
| Washington Territory | ..... | 1,200 | ..... | 2,317 | 540 | 1,857 |
| Total far western States | 5,000 | 18,110 | 31,512 | 39,324 | 22,174 | 11,170 |
| Grand total | 4,295,414 | 4,641,564 | 5,178,122 | 5,146,972 | 4,589,613 | 4,529,869 |

The leadership of Pennsylvania as the producer of about one-half the pig iron that is yearly made in the United States has long been known, and the steadiness of its production for a long series of years is fairly

illustrated in the table, but in the other States and in the Territories there has been less constancy in production, and this, too, is illustrated in the table. A great shrinkage in the last six years is observable in New England, New York, New Jersey, Maryland, Wisconsin, and Missouri, while there has been a great increase in the same time in Virginia, Alabama, Tennessee, and Illinois. Various causes have contributed to these changes, most prominent among which is the greater cheapness with which the raw materials of manufacture can be brought together in the States which show progress than in those which have fallen behind. The division of the table which includes the southern States shows an increase in production during the past six years of nearly 52 per cent., while the production of the middle and western States has been practically stationary, and that of New England has declined about 60 per cent. In one of the southern States, Virginia, the increase from 1880 to 1885 was from 29,934 tons to 163,782 tons, or 447 per cent.; in another southern State, Tennessee, the increase was from 70,873 tons to 161,199 tons, or 127 per cent.; and in another southern State, Alabama, the increase was from 77,190 tons to 227,438 tons, or 194 per cent. Nine new furnaces are now in course of erection in Alabama and other southern States. In the Rocky Mountain and Pacific division the manufacture of pig iron is making slow progress, but it must grow with the lapse of years. The whole number of blast furnaces in the United States at the close of 1885, not including those which had been abandoned or were not likely ever again to be put in blast, was 591, of which 276 were then in blast and 315 were out of blast. The furnaces out of blast were generally the smallest and least favorably situated.

*Rails.*—In the following table the production of iron and steel rails during the last six years is given. Only thirteen States and one Territory made rails in 1885, whereas nineteen States and one Territory made rails in 1880, and twenty States and one Territory in 1881. Pennsylvania, as the table shows, made a larger proportion of the total quantity of rails in late years than in preceding years. Several States have absolutely and others have virtually dropped out of the list as producers of rails, a result which is due to the general substitution of steel for iron rails. Other States, particularly New York and Ohio, which have made steel rails for many years, show a greatly decreased production of rails in late years, which is partly explained by the fact that the low prices which have ruled for steel rails have made the manufacture of steel in other finished forms in these States more profitable, and partly by the fact that the decreased demand for steel rails in 1883, 1884, and 1885 has tended to restrict their production in the States referred to, as well as in the other States.

*Production of iron and steel rails in the United States, by States and Territories, in the last six years.*

| States and Territories. | Short tons of 2,000 pounds. | | | | | |
|---|---|---|---|---|---|---|
| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
| Pennsylvania | 670,198 | 891,179 | 850,908 | 857,818 | 775,872 | 743,761 |
| Illinois | 322,883 | 433,420 | 362,250 | 232,005 | 294,458 | 312,042 |
| Ohio | 133,487 | 153,596 | 113,806 | 62,518 | 25,175 | 14,387 |
| Massachusetts | 9,672 | 2,622 | 15,707 | 12,465 | 5,862 | 6,781 |
| New York | 109,921 | 109,283 | 105,021 | 76,020 | 31,625 | 6,580 |
| California | 4,722 | 6,035 | 8,200 | 7,460 | 2,937 | 3,393 |
| Colorado | 4,500 | 1,643 | 18,217 | 19,688 | 4,030 | 2,907 |
| Indiana | 41,523 | 44,645 | 28,173 | 16,309 | 1,844 | 1,914 |
| Alabama | 300 | 2,300 | 728 | 680 | 500 | 1,000 |
| Wisconsin | 30,207 | 41,165 | 24,685 | 1,259 | 250 | 448 |
| West Virginia | 2,155 | 3,152 | 1,436 | 775 | 899 | 351 |
| Texas | ..... | ..... | ..... | ..... | 200 | 250 |
| Wyoming Territory | 9,421 | 11,886 | 13,253 | 6,845 | 282 | 220 |
| Tennessee | 18,552 | 32,660 | 25,390 | 2,650 | 500 | 181 |
| Kentucky | 14,336 | 5,005 | 2,000 | ..... | 300 | ..... |
| Virginia | 107 | 640 | ..... | ..... | 95 | ..... |
| Missouri | 35,746 | 64,226 | 85,528 | 64,142 | 22 | ..... |
| New Jersey | ..... | 244 | ..... | 60 | ..... | ..... |
| Vermont | 17,650 | 15,200 | 26,100 | ..... | ..... | ..... |
| Kansas | 29,085 | 19,016 | 7,067 | ..... | ..... | ..... |
| Maine | ..... | 2,183 | 325 | ..... | ..... | ..... |
| Georgia | 485 | 4,000 | ..... | ..... | ..... | ..... |
| Maryland | 6,887 | ..... | ..... | ..... | ..... | ..... |
| Total | 1,461,837 | 1,844,100 | 1,688,794 | 1,360,694 | 1,144,851 | 1,094,215 |

*Rolled iron.*—With the exception of a few hundred tons of bar iron which are annually made in a few old-fashioned forges in the mountainous districts of two or three southern States what is called finished iron is now produced in this country entirely by rolling. The substitution of rolled iron for hammered iron in the United States is entirely the work of the last seventy years, and it is within the recollection of many persons that hammered iron was long preferred by many blacksmiths to rolled iron. In the last six years thirty States and one Territory have manufactured iron in rolling mills. This branch of our iron industry is even more widely distributed than the manufacture of pig iron. In the following table our production of all kinds of rolled iron, including iron rails, is given.

*Production of all kinds of rolled iron in the United States, by States and Territories, in the last six years.*

| States and Territories. | Short tons of 2,000 pounds. | | | | | |
|---|---|---|---|---|---|---|
| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
| Maine | 7,639 | 7,616 | 10,862 | 10,662 | 9,638 | 8,219 |
| New Hampshire | 3,100 | 3,000 | 3,508 | 2,158 | 4,314 | 500 |
| Vermont | 1,650 | ..... | ..... | ..... | ..... | ..... |
| Massachusetts | 114,250 | 116,846 | 111,388 | 100,418 | 77,560 | 75,074 |
| Rhode Island | 7,632 | 10,769 | 11,877 | 14,405 | 14,000 | 13,723 |
| Connecticut | 16,046 | 17,589 | 20,676 | 18,541 | 15,054 | 15,054 |
| Total New England States | 150,317 | 155,820 | 158,311 | 146,184 | 120,566 | 112,570 |
| New York | 147,601 | 123,366 | 138,541 | 105,644 | 86,955 | 79,853 |
| New Jersey | 64,622 | 71,286 | 96,441 | 76,109 | 61,046 | 49,573 |
| Pennsylvania | 1,032,602 | 1,254,866 | 1,123,886 | 1,081,163 | 913,046 | 940,865 |
| Delaware | 29,806 | 34,275 | 38,261 | 35,384 | 28,015 | 28,721 |
| Total middle States | 1,274,631 | 1,483,793 | 1,397,129 | 1,298,300 | 1,089,062 | 1,099,012 |

*Production of all kinds of rolled iron in the United States, &c.*—Continued.

| States and Territories. | Short tons of 2,000 pounds. | | | | | |
|---|---|---|---|---|---|---|
| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
| Maryland and District of Columbia | 41,208 | 33,034 | 33,807 | 29,099 | 33,856 | 17,581 |
| Virginia | 37,734 | 41,002 | 40,044 | 30,751 | 28,286 | 31,989 |
| Georgia | 1,507 | 7,000 | | | | |
| Alabama | 6,604 | 11,072 | 9,188 | 8,336 | 17,895 | 24,850 |
| Texas | | | | | 1,000 | 1,000 |
| West Virginia | 63,601 | 75,547 | 66,107 | 79,894 | 64,632 | 9,992 |
| Kentucky | 51,406 | 29,915 | 61,096 | 58,263 | 29,212 | 21,736 |
| Tennessee | 25,402 | 33,793 | 38,770 | 22,454 | 15,217 | 11,344 |
| Missouri | 26,558 | 16,641 | 18,145 | 15,833 | 18,580 | 11,547 |
| Total southern States | 254,020 | 248,004 | 267,157 | 244,630 | 208,678 | 130,039 |
| Ohio | 308,566 | 345,727 | 361,608 | 377,962 | 310,568 | 269,263 |
| Indiana | 80,428 | 82,430 | 71,626 | 55,887 | 39,028 | 35,540 |
| Illinois | 109,429 | 148,818 | 93,943 | 121,702 | 95,815 | 80,356 |
| Michigan | 19,804 | 20,605 | 11,824 | 11,900 | 9,571 | 12,840 |
| Wisconsin | 64,890 | 88,643 | 64,296 | 40,195 | 53,628 | 38,959 |
| Minnesota | | | | | 200 | 1,200 |
| Kansas | 37,985 | 29,544 | 17,867 | | | |
| Iowa | | | | | | 809 |
| Nebraska | 3,000 | 1,583 | 3,000 | 3,250 | 2,000 | 3,000 |
| Total western States | 624,102 | 717,350 | 624,164 | 610,896 | 510,810 | 441,958 |
| Colorado | 4,500 | 3,949 | 4,739 | 7,844 | 5,619 | 5,538 |
| Wyoming Territory | 9,821 | 15,172 | 16,488 | 11,288 | 1,745 | 2,430 |
| California | 15,277 | 19,839 | 25,843 | 29,732 | 20,827 | 12,979 |
| Total far western States | 29,598 | 38,960 | 47,070 | 48,864 | 28,191 | 20,947 |
| Grand total | 2,332,668 | 2,643,927 | 2,493,831 | 2,348,874 | 1,957,307 | 1,804,526 |

This table shows that a large number of States and Wyoming Territory have greatly decreased their production of rolled iron. This result has in almost every instance been due to the almost total destruction of the iron-rail industry and to the general tendency to substitute steel for iron, even Pennsylvania, which heads the list of producers of rolled iron, in late years falling behind its previous record. As will appear by a table which will be given hereafter, most of the States which show a marked decline in the production of rolled iron have greatly increased their production of steel. In Georgia and Vermont the manufacture of rolled iron has entirely ceased, and in Kansas it has been entirely suspended.

*Nails.*—The following table shows the States which made cut nails within the last six years, 17 in all, Pennsylvania, as usual, leading all her sister States. Wire nails and railroad spikes are not included in the table. Down to 1883 all the cut nails made in this country were made of iron. In that year we made 18,224 kegs of steel nails; in 1884 were made 393,482 kegs; and in 1885, 1,823,127 kegs, each year including a small quantity of combined iron and steel nails. The rapid progress in the manufacture of steel nails in 1884 and 1885 is as notable as that of steel rails in earlier years.

*Production of cut nails in the United States, by States, in the last six years.*

| States. | Kegs of 100 ponnds. | | | | | |
|---|---|---|---|---|---|---|
| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
| Pennsylvania | 1,737,560 | 1,914,706 | 1,949,405 | 2,430,552 | 2,281,676 | 2,457,916 |
| Ohio | 824,683 | 860,665 | 796,857 | 1,249,700 | 1,310,715 | 920,539 |
| West Virginia | 1,025,155 | 1,241,102 | 1,023,711 | 1,327,484 | 1,098,611 | 778,069 |
| Massachusetts | 532,299 | 525,089 | 592,276 | 677,540 | 557,195 | 654,318 |
| Illinois | 290,132 | 352,643 | 462,956 | 526,108 | 712,650 | 376,361 |
| Indiana | 289,948 | 326,496 | 394,682 | 413,380 | 443,234 | 274,271 |
| Virginia | 123,728 | 127,566 | 169,806 | 161,279 | 207,678 | 226,437 |
| California | ..... | ..... | ..... | 111,500 | 129,332 | 203,567 |
| New Jersey | 294,122 | 248,521 | 360,340 | 338,107 | 305,307 | 181,680 |
| Alabama | ..... | ..... | ..... | 20,000 | 100,000 | 137,000 |
| Kentucky | 120,900 | 69,000 | 149,382 | 144,686 | 41,522 | 135,628 |
| Tennessee | 64,503 | 94,495 | 171,413 | 212,358 | 120,164 | 98,851 |
| Wisconsin | ..... | ..... | ..... | ..... | 162,851 | 86,257 |
| Colorado | ..... | ..... | 16,103 | 62,969 | 55,944 | 64,310 |
| Nebraska | 60,000 | 31,667 | 60,000 | 65,000 | 40,000 | 60,000 |
| New York | 7,482 | 2,256 | 166 | 14,768 | 14,500 | 41,611 |
| Maine | ..... | ..... | ..... | 7,306 | ..... | ..... |
| Total | 5,370,512 | 5,794,206 | 6,147,097 | 7,762,737 | 7,581,379 | 6,696,815 |

*Steel.*—The following table gives the production of all kinds of steel in the steel-making States in the last six years. Seventeen States appear in the table. The great stride made by Pennsylvania in the manufacture of steel in this period will be noticed. The marked advance made by West Virginia in 1884 and 1885 was due to the substitution of steel for iron in the manufacture of nails.

*Production of all kinds of steel in the United States, by States, in the last six years.*

| States. | Short tons of 2,000 pounds. | | | | | |
|---|---|---|---|---|---|---|
| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
| New Hampshire | 5,000 | 5,000 | 3,753 | 3,180 | 6,100 | 2,610 |
| Vermont | 3,800 | 4,700 | 4,300 | ..... | ..... | ..... |
| Massachusetts | 11,860 | 15,620 | 18,023 | 15,313 | 12,208 | 21,292 |
| Connecticut | 632 | 2,260 | 460 | 1,997 | 1,772 | 2,481 |
| Total New England States | 21,292 | 27,580 | 26,536 | 20,490 | 20,080 | 26,383 |
| New York | 101,213 | 125,037 | 129,353 | 117,341 | 62,680 | 47,903 |
| New Jersey | 13,120 | 19,500 | 17,800 | 13,539 | 16,999 | 12,072 |
| Pennsylvania | 755,632 | 976,267 | 1,068,706 | 1,179,974 | 1,157,376 | 1,251,172 |
| Total middle States | 869,965 | 1,120,804 | 1,215,859 | 1,310,854 | 1,237,055 | 1,311,147 |
| Maryland | ..... | ..... | ..... | ..... | ..... | 900 |
| West Virginia | ..... | ..... | ..... | ..... | 16,945 | 49,712 |
| Kentucky | 600 | 150 | ..... | ..... | ..... | ..... |
| Tennessee | 4,000 | 4,000 | 4,000 | 3,750 | 8 | 20 |
| Missouri | 45,794 | 80,810 | 107,210 | 79,452 | ..... | 6,969 |
| Total southern States | 50,394 | 84,960 | 111,210 | 83,202 | 16,953 | 57,601 |
| Ohio | 144,369 | 159,032 | 163,280 | 157,482 | 105,389 | 138,280 |
| Illinois | 310,995 | 386,536 | 404,697 | 279,637 | 347,130 | 371,939 |
| Michigan | ..... | ..... | ..... | ..... | 1,833 | 3,000 |
| Total western States | 455,364 | 545,568 | 567,977 | 437,119 | 454,352 | 513,219 |
| Colorado | ..... | ..... | 23,513 | 22,694 | 6,097 | 2,300 |
| California | ..... | ..... | ..... | ..... | 2,448 | 6,700 |
| Total far western States | ..... | ..... | 23,513 | 22,694 | 8,545 | 9,000 |
| Grand total | 1,397,015 | 1,778,912 | 1,945,095 | 1,874,359 | 1,736,985 | 1,917,350 |

During 1884 and 1885, but particularly in the latter year, there was great activity in this country in the erection of new steel works. These works were generally Clapp-Griffiths and other "Little Bessemer" plants, but some standard Bessemer plants and a few open-hearth plants were also erected. This activity still continues, and there will be many new steel plants erected before the close of the year 1886. There is particularly noticeable a revival of interest in the manufacture of steel by the open-hearth process. We are making very little progress in the extension of our facilities for the manufacture of crucible steel. The manufacture of blister steel as a commercial product is virtually an extinct industry in this country.

On the 19th of April 1886, the South Tredegar Iron Company of Chattanooga, Tennessee, made in a small converter the first Bessemer steel ever made in the southern States south of West Virginia. It was made by the original Bessemer process from southern ore, which had been smelted into pig iron by the Cranberry Iron and Coal Company of North Carolina. The product of this converter is to be used in the manufacture of steel nails. Another and larger standard Bessemer steel plant is at once to be erected at Chattanooga by the Roane Iron Company, for the manufacture of steel rails.

*Detailed statistics for twelve years.*—Comprehensive as the foregoing tables are, it is possible to supplement them with another table which gives in detail the production of certain forms of iron and steel for the twelve years which begin with 1874 and end with 1885.

*Production in detail of leading articles of iron and steel in the United States, from* 1874 *to* 1885.

| Years. | Short tons of 2,000 pounds. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Spiegeleisen, included in pig-iron statistics. | Kegs of cut nails and spikes. | Bessemer steel rails. | Open-hearth steel rails. | Crucible steel ingots. | Open-hearth steel ingots. | Bessemer steel ingots. | Miscellaneous steel. |
| 1874 | ..... | 4, 912, 180 | 144, 944 | ..... | 36, 328 | 7, 000 | 191, 933 | 6, 353 |
| 1875 | 7, 832 | 4, 726, 881 | 290, 863 | ..... | 39, 401 | 9, 050 | 375, 517 | 12, 607 |
| 1876 | 6, 616 | 4, 157, 814 | 412, 461 | ..... | 39, 382 | 21, 490 | 525, 996 | 10, 306 |
| 1877 | 8, 845 | 4, 828, 918 | 432, 169 | ..... | 40, 430 | 25, 031 | 560, 587 | 11, 924 |
| 1878 | 10, 674 | 4, 396, 130 | 550, 398 | 9, 397 | 42, 906 | 36, 126 | 732, 226 | 8, 556 |
| 1879 | 13, 931 | 5, 011, 021 | 683, 964 | 9, 149 | 56, 780 | 56, 290 | 928, 972 | 5, 464 |
| 1880 | 19, 603 | 5, 370, 512 | 954, 460 | 13, 615 | 72, 424 | 112. 953 | 1, 203, 173 | 8, 465 |
| 1881 | 21, 086 | 5, 794, 206 | 1, 330, 302 | 25, 217 | 89, 762 | 146, 946 | 1, 539, 157 | 3, 047 |
| 1882 | 21, 963 | 6, 147, 097 | 1, 438, 155 | 22, 765 | 85, 089 | 160, 542 | 1, 696, 450 | 3, 014 |
| 1883 | 24, 574 | 7, 762, 737 | 1, 286, 554 | 9, 186 | 80, 455 | 133, 679 | 1, 654, 627 | 5, 598 |
| 1884 | 33, 893 | 7, 581, 379 | 1, 116, 621 | 2, 670 | 59, 662 | 131, 617 | 1, 540, 595 | 5, 111 |
| 1885 | 34, 671 | 6, 696, 815 | 1, 074, 607 | 4, 793 | 64, 511 | 149, 381 | 1, 701, 762 | 1, 696 |

*Production of iron ore.*—In a paper contributed to the special report on the mineral resources of the United States for 1883 and 1884, the domestic production of iron ore in 1884 which went into consumption in that year was estimated at 7,718,129 long tons. By the same method of calculation which was then observed the domestic iron ore which was

produced and consumed in 1885 may be estimated at 7,600,000 tons. To ascertain the total quantity of iron ore which was consumed in these two years the quantity imported in each year must be added to the above figures.

The production of iron ore by all the iron-ore mines of the country cannot be obtained except in census years. The production by the leading mines in the last three years has, however, been carefully ascertained, and the statistics are given below. They embrace more than half the production of the whole country in each of the years mentioned.

*Production of iron ore in certain leading districts of the United States in* 1883, 1884, *and* 1885.

| Districts. | Long tons of 2,240 pounds. | | |
|---|---|---|---|
| | 1883. | 1884. | 1885. |
| Marquette range, of Lake Superior | 1,305,425 | 1,557,389 | 1,430,422 |
| Menominee range, of Lake Superior | 1,047,863 | 895,634 | 689,435 |
| Vermillion Lake mines, of Minnesota | Not opened. | 62,124 | 225,484 |
| Gogebic mines, of Michigan | Not opened. | 1,022 | 111,661 |
| Miscellaneous mines, of Lake Superior | ..... | 1,879 | 441 |
| Total production of Lake Superior mines | 2,353,288 | 2,518,048 | 2,448,443 |
| Missouri | 295,430 | 233,225 | 234,162 |
| Cornwall, Pennsylvania | 363,143 | 412,320 | 508,864 |
| Chateaugay mines, near Lake Champlain | 194,704 | 214,394 | 143,278 |
| Other Lake Champlain mines, including the Port Henry and Crown Point mines | 305,300 | 290,500 | 235,799 |
| New Jersey | 521,416 | 393,710 | 330,000 |
| Salisbury district, Connecticut | 35,000 | 25,000 | 32,000 |
| Hudson River Ore and Iron Company, New York | 20,000 | 90,000 | 55,000 |
| Cranberry mines, North Carolina | 19,377 | 3,998 | 17,839 |
| Tennessee Coal, Iron and Railroad Company's Inman mines | 36,437 | 70,757 | 94,319 |
| Total of all the above districts | 4,144,095 | 4,251,952 | 4,099,704 |

The development of the new iron-ore fields in Minnesota and Michigan which commenced in 1884 was continued with great energy in 1885. The shipments of iron ore from the Vermillion district in Minnesota increased from 62,124 long tons in 1884 to 225,484 tons in 1885. The shipments from the Gogebic district in Michigan increased from 1,022 tons in 1884 to 111,661 tons in 1885. The ores of these two districts are adapted to the manufacture of Bessemer steel by the original process. During 1885 a rich manganiferous iron-ore field near Batesville, in Arkansas, attracted the attention of capitalists, who have since vigorously undertaken its development. The ore is being used in the manufacture of spiegeleisen and ferro-manganese, our production of which aggregated only 34,671 short tons in 1885, but which it is now expected will be largely increased. The production of iron ore by the Cranberry mines of North Carolina amounted to 17,839 long tons in 1885. The ore from these mines is adapted to the manufacture of steel by the original Bessemer process, and pig iron made from this ore is now used in the manufacture of steel by this method at Chattanooga.

*Imports of iron ore.*—The importation of iron ore in the last seven calendar years has been as follows:

*Imports of iron ore, 1879 to 1885.*

| Years. | Long tons. | Years. | Long tons. |
|---|---|---|---|
| 1879 | 284,141 | 1883 | 490,875 |
| 1880 | 493,408 | 1884 | 487,820 |
| 1881 | 782,887 | 1885 | 390,786 |
| 1882 | 589,655 | | |

Previous to 1879 the imports of iron ore did not exceed 100,000 tons annually. In the present year they will probably amount to 1,000,000 tons, the largest annual importation in our history.

*Causes of the activity of the United States in the manufacture of iron and steel.*—The mechanical genius and the restless energy of the American people lie, of course, at the foundation of all our industrial achievements. In the development of our iron and steel industries the possession of all the necessary raw materials of manufacture gave opportunity for the employment of the national traits just mentioned. The rapid growth of the country in population created an active demand for iron and steel for ordinary domestic and mechanical purposes, but the stimulus given to the building of railroads after 1850 gave to the manufacture of these products its greatest opportunity. More than one-half of all the iron and steel that has been produced in this country since 1865 has gone into the construction and equipment of our railroads. We have to-day more miles of railroad than the whole of Europe, and more than two-fifths of all the railroad mileage of the world. The greatest activity in the building of railroads in this country has prevailed, however, during the last twenty-one years. At the beginning of 1865, when our tables begin, we had about 34,000 miles of railroad in operation; at the present time we have about 130,000 miles. Another cause that has greatly contributed to the wonderful development of our iron and steel industries during the period under review in these pages is the economic and fiscal policy of the National Government in discouraging by customs duties the importation of iron and steel from other countries.

*American imports of iron and steel.*—It has been sufficiently shown that this country is a large producer of iron and steel. The statistics of our production of these articles do not, however, show the magnitude of their consumption by our people. We export only very small quantities of iron and steel, principally in the form of machinery, but have been large importers of iron and steel in all forms, which we have consumed in addition to the large quantities we have ourselves produced. Our imports of iron and steel during the last fifteen calendar years have been as follows. The quantities of pig, bar, band, plate, and sheet iron, rails, old iron, and tin plates are given for every year mentioned, and for 1882 and succeeding years the quantities of other iron and steel which could not be obtained for preceding years are added:

*Imports of iron and steel, 1871 to 1885.*

| Years. | Long tons. | Years. | Long tons. |
|---|---|---|---|
| 1871 | 1,141,933 | 1879 | 769,984 |
| 1872 | 1,183,066 | 1880 | 1,886,019 |
| 1873 | 640,858 | 1881 | 1,180,749 |
| 1874 | 301,647 | 1882 | 1,192,296 |
| 1875 | 239,712 | 1883 | 694,530 |
| 1876 | 204,211 | 1884 | 654,696 |
| 1877 | 211,408 | 1885 | 578,478 |
| 1878 | 211,102 | | |

In the following table the quantities and values of pig iron and iron and steel rails which have been imported during the last thirty-one fiscal years are given:

*Quantities and values of pig iron and iron and steel rails imported into the United States from 1855 to 1885.*

| Fiscal years. | Pig iron. | | Iron and steel rails. | |
|---|---|---|---|---|
| | Long tons. | Values. | Long tons. | Values. |
| 1855 | 98,925 | $1,979,463 | 127,516 | $4,993,900 |
| 1856 | 59,012 | 1,171,085 | 155,495 | 6,179,280 |
| 1857 | 51,794 | 1,001,742 | 179,305 | 7,455,596 |
| 1858 | 41,986 | 739,949 | 75,745 | 2,987,576 |
| 1859 | 72,517 | 1,449,200 | 69,965 | 2,274,632 |
| 1860 | 71,498 | 1,005,865 | 122,175 | 3,709,376 |
| 1861 | 74,026 | 979,916 | 74,490 | 2,162,695 |
| 1862 | 22,247 | 285,323 | 8,611 | 222,907 |
| 1863 | 31,007 | 435,194 | 17,088 | 540,494 |
| 1864 | 102,223 | 1,288,424 | 118,714 | 3,904,017 |
| 1865 | 50,652 | 806,552 | 77,518 | 2,903,828 |
| 1866 | 102,392 | 1,683,186 | 78,007 | 2,806,390 |
| 1867 | 112,042 | 1,831,465 | 96,272 | 3,317,862 |
| 1868 | 112,133 | 1,778,977 | 151,097 | 4,373,162 |
| 1869 | 136,975 | 2,138,030 | 237,703 | 7,305,845 |
| 1870 | 153,283 | 2,509,280 | 279,765 | 9,669,571 |
| 1871 | 178,138 | 3,106,490 | 458,055 | 17,360,297 |
| 1872 | 247,528 | 5,122,318 | 531,536 | 22,056,635 |
| 1873 | 215,495 | 7,203,769 | 357,629 | 19,740,702 |
| 1874 | 92,041 | 3,288,022 | 148,918 | 10,758,435 |
| 1875 | 53,748 | 1,458,668 | 42,082 | 2,932,311 |
| 1876 | 79,455 | 1,918,547 | 4,768 | 321,620 |
| 1877 | 67,922 | 1,556,415 | 30 | 1,464 |
| 1878 | 55,000 | 1,250,057 | 11 | 530 |
| 1879 | 87,576 | 1,924,128 | 2,611 | 70,071 |
| 1880 | 754,657 | 14,654,227 | 152,791 | 4,952,286 |
| 1881 | 417,849 | 8,766,461 | 302,294 | 10,331,768 |
| 1882 | 496,045 | 9,213,556 | 295,666 | 9,440,943 |
| 1883 | 433,602 | 7,944,982 | 118,062 | 3,834,740 |
| 1884 | 283,172 | 4,932,598 | 7,971 | 252,446 |
| 1885 | 151,959 | 2,689,263 | 4,203 | 104,494 |

The above table exhibits the magnitude of our imports of iron and steel in a light that may well startle the reader. And yet it embraces only three products, pig iron and iron and steel rails. Full statistics of all our imports of iron and steel for the whole period covered by the table are not available. In the following table are given the imports of old iron rails, old iron, and scrap iron for the fifteen calendar years from 1871 to 1885. Iron in these forms takes the place of pig iron.

*Imports of old rails, old iron, and scrap iron,* 1871 *to* 1885.

| Years. | Long tons. | Values. | Years. | Long tons. | Values. |
|---|---|---|---|---|---|
| 1871 | 196,732 | $4,845,092 | 1879 | 221,812 | $3,700,200 |
| 1872 | 248,444 | 7,617,463 | 1880 | 619,887 | 14,704,879 |
| 1873 | 97,177 | 3,061,759 | 1881 | 134,917 | 2,705,072 |
| 1874 | 36,279 | 949,752 | 1882 | 146,956 | 2,736,483 |
| 1875 | 25,846 | 498,682 | 1883 | 64,286 | 1,014,863 |
| 1876 | 12,633 | 236,596 | 1884 | 26,957 | 340,420 |
| 1877 | 9,735 | 140,593 | 1885 | 13,821 | 151,714 |
| 1878 | 5,558 | 65,619 | | | |

Our imports of tinplates have in recent years assumed extraordinary proportions. The following table shows their growth in the calendar years from 1871 to 1885. All our imports of tinplates come from Great Britain. We do not ourselves make one pound of tinplates.

*Imports of tinplates,* 1871 *to* 1885.

| Years. | Long tons. | Values. | Years. | Long tons. | Values. |
|---|---|---|---|---|---|
| 1871 | 82,969 | $9,946,373 | 1879 | 154,250 | $13,227,659 |
| 1872 | 85,629 | 13,893,450 | 1880 | 158,049 | 16,478,110 |
| 1873 | 97,177 | 14,240,868 | 1881 | 183,005 | 14,886,907 |
| 1874 | 79,778 | 13,057,658 | 1882 | 213,987 | 17,975,161 |
| 1875 | 91,054 | 12,093,885 | 1883 | 221,233 | 18,156,773 |
| 1876 | 89,946 | 9,416,816 | 1884 | 216,181 | 16,858,650 |
| 1877 | 112,479 | 10,679,028 | 1885 | 228,596 | 15,991,152 |
| 1878 | 107,864 | 9,069,967 | | | |

In the following table are given the values of all imports of iron and steel, including pig iron, iron and steel rails, bar iron, plate and sheet iron, old rails, scrap iron and scrap steel, cotton ties, steel in miscellaneous forms, tinplates, wire rods and wire, firearms, hardware, cutlery, machinery, &c., in the fifteen calendar years from 1871 to 1885.

*Summary of iron and steel imports,* 1871 *to* 1885.

| Years. | Values. | Years. | Values. | Years. | Values. |
|---|---|---|---|---|---|
| 1871 | $57,866,299 | 1876 | $20,016,603 | 1881 | $61,555,077 |
| 1872 | 75,617,677 | 1877 | 19,874,399 | 1882 | 67,075,125 |
| 1873 | 60,005,538 | 1878 | 18,013,010 | 1883 | 47,506,306 |
| 1874 | 37,652,192 | 1879 | 33,331,569 | 1884 | 37,078,122 |
| 1875 | 27,363,101 | 1880 | 80,443,362 | 1885 | 31,144,530 |

The above values aggregate $674,542,910, a sum so large that in the absence of the accompanying statistics of production which have been presented it would seem to the uninformed reader that our iron and steel industries had not been fully developed during the last fifteen years.

That this country is not likely to become in the immediate future a large exporter of iron and steel in competition with countries which possess cheap labor, and which find the raw materials in the manufacture of these products in closer proximity than they are found with us,

is a proposition which does not require further verification than is afforded in the following extract from Sir Lowthian Bell's recent volume on "The Iron Trade of the United Kingdom":

"The geographical position of iron ore and fuel in the United States, as at present known, renders it impossible that the iron trade, as carried on in the northern portion of the Union, can ever become one of a largely exporting character, so far as pig iron, rails, and other cheap forms of the metal are concerned. The disadvantage entailed upon the manufacture of iron by the distance at which the minerals lie apart is increased by the expense of sending the produce to a seaport, and, so far as the present time is concerned, by the very high price of labor. To what extent the southern States may be able to compete with Europe in an export trade time only will show. Admitting, however, that all the expectations regarding Alabama, Georgia, and Tennessee be realized, this can, in my opinion, only be done successfully when the cost of reaching the port of delivery is considerably below that from European iron works."

*British exports of iron and steel.*—In this connection the decline in the exports of all leading articles of iron and steel from Great Britain to all countries in the last four years is worthy of notice, and the statistics are here added.

*British exports of iron and steel,* 1882 *to* 1885.

| Articles. | Long tons of 2,240 pounds. | | | |
|---|---|---|---|---|
| | 1882. | 1883. | 1884. | 1885. |
| Pig iron | 1,758,072 | 1,564,048 | 1,269,576 | 960,160 |
| Bar, angle, bolt, and rod iron | 313,155 | 288,271 | 206,489 | 264,272 |
| Railroad iron, all kinds | 936,949 | 971,165 | 728,540 | 711,415 |
| Wire, and manufactures of, except telegraph wire | 86,653 | 62,620 | 52,968 | 55,086 |
| Hoops, sheets, and boiler and armor plates | 342,599 | 347,782 | 348,298 | 361,471 |
| Tin plates and sheets | 265,039 | 269,375 | 288,614 | 297,728 |
| Cast and wrought iron | 328,262 | 355,842 | 376,367 | 349,978 |
| Old iron | 132,033 | 97,475 | 68,141 | 84,945 |
| Steel, unwrought | 172,329 | 73,131 | 56,934 | 60,466 |
| Manufactures of steel or steel and iron combined | 18,461 | 13,599 | 11,064 | 12,880 |
| Total exports | 4,353,552 | 4,043,308 | 3,496,991 | 3,128,401 |
| Total values | £31,598,306 | £28,590,216 | £24,496,065 | £21,717,136 |

*Our progress in the manufacture of iron and steel compared with that of other countries.*—Nearly all the civilized countries of the world have made great strides in the manufacture and use of iron and steel in the last hundred years, but in the last fifty years, following the general introduction of railroads, this progress has been most marked. In the United States it has been really phenomenal during the twenty-one years under consideration in this paper.

The following table shows the progress made by eight leading countries of the world in the manufacture of pig iron since the introduction of the Bessemer process into the United States twenty-one years ago.

Pig iron is the raw material from which nearly all finished iron and steel is now made, and the statistics of its production in any country furnish a correct measure of the progress of that country in the manufacture of all iron and steel products, each country, however, devoting its attention to some products more than to others. The comparative table which is here given is in long tons of 2,240 pounds for the United States and Great Britain, and in metric tons of 2,204 pounds for all other countries. Miscellaneous castings from the blast furnace in some of the continental countries of Europe are counted as pig iron.

*Production of pig iron in the last twenty-one years in the principal iron-producing countries.*

| Years. | Long tons of 2,240 pounds. | | Metric tons of 2,204 pounds. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Great Britain. | United States. | Germany. | France. | Belgium. | Austro-Hungary. | Sweden. | Russia. |
| 1865 | 4,819,254 | 831,770 | ..... | ..... | 470,767 | ..... | ..... | ..... |
| 1866 | 4,523,897 | 1,205,663 | ..... | 1,260,348 | ..... | 319,709 | ..... | ..... |
| 1867 | 4,761,023 | 1,305,023 | 1,113,606 | 1,229,044 | 423,069 | 361,038 | ..... | ..... |
| 1868 | 4,970,206 | 1,431,250 | 1,264,347 | 1,235,308 | 435,754 | 425,071 | ..... | ..... |
| 1869 | 5,445,757 | 1,711,287 | 1,413,029 | 1,380,965 | 534,319 | 450,567 | 285,065 | ..... |
| 1870 | 5,963,515 | 1,665,179 | 1,391,124 | 1,178,114 | 565,234 | 452,244 | 293,438 | 354,032 |
| 1871 | 6,627,179 | 1,706,793 | 1,563,682 | 859,641 | 609,230 | 476,627 | 293,277 | 353,710 |
| 1872 | 6,741,929 | 2,548,713 | 1,988,394 | 1,217,838 | 655,565 | 531,850 | 334,788 | 393,065 |
| 1873 | 6,566,451 | 2,560,963 | 2,240,574 | 1,366,971 | 607,373 | 594,980 | 339,685 | 378,387 |
| 1874 | 5,991,408 | 2,401,262 | 1,906,262 | 1,423,308 | 532,790 | 545,742 | 332,154 | 374,355 |
| 1875 | 6,365,462 | 2,023,733 | 2,029,389 | 1,416,228 | 540,473 | 504,347 | 343,551 | 420,484 |
| 1876 | 6,555,997 | 1,868,961 | 1,846,345 | 1,453,112 | 490,508 | 450,933 | 344,834 | ..... |
| 1877 | 6,608,664 | 2,066,594 | 1,932,725 | 1,400,000 | 470,488 | 409,000 | 336,370 | ..... |
| 1878 | 6,381,051 | 2,301,215 | 2,147,611 | 1,417,072 | 493,544 | 424,249 | 333,496 | 409,633 |
| 1879 | 5,995,337 | 2,741,853 | 2,226,587 | 1,344,759 | 448,371 | 404,160 | 342,547 | 429,865 |
| 1880 | 7,749,233 | 3,835,191 | 2,729,037 | 1,725,293 | 595,704 | 465,518 | 405,765 | 441,285 |
| 1881 | 8,377,364 | 4,144,254 | 2,914,009 | 1,899,861 | 624,736 | 543,000 | 435,428 | 462,027 |
| 1882 | 8,493,287 | 4,623,323 | 3,380,806 | 2,039,067 | 727,000 | 611,681 | 398,945 | 498,400 |
| 1883 | 8,490,224 | 4,595,510 | 3,469,719 | 2,067,387 | 770,659 | 719,037 | 422,627 | ..... |
| 1884 | 7,528,966 | 4,097,868 | 3,572,155 | 1,855,247 | 750,812 | 771,502 | 430,534 | ..... |
| 1885 | 7,250,657 | 4,044,526 | 3,751,775 | 1,629,051 | 714,677 | 805,631 | 425,000 | ..... |

This table shows that during the last twenty-one years Great Britain increased its production of pig-iron from the first year named in the table to the highest annual product 76 per cent.; the United States, 456 per cent.; Germany, 237 per cent.; France, 64 per cent.; Belgium, 64 per cent.; Austro-Hungary, 152 per cent.; and Sweden, 53 per cent. Next to the United States Germany has made the greatest relative progress in this period in the production of pig-iron. The country which has experienced during the past few years of general depression the most serious check in the growth of its pig-iron industry is Great Britain. In years gone by the large importations of pig-iron and of finished iron and steel from Great Britain into this country have been a very important factor in building up the British iron and steel industries, but these importations have now very greatly diminished. It is exceedingly probable that the gap which now separates our production of pig iron from that of Great Britain will be entirely closed within the

next five years if the rates of duties now imposed by the United States on foreign iron and steel are maintained for that length of time. As late as 1871 Great Britain made one-half of all the pig-iron made in the world; since that year her proportion of the world's production has steadily declined. It will be observed that in 1884 and 1885 her production greatly declined; that of the United States also declined in the two years mentioned, but not to so large an extent nor in as large proportion. In the present year Great Britain's production will probably not exceed that of 1885, while that of the United States promises to exceed that of 1885 by one million tons.

*The world's production of pig iron.*—From the most reliable information that is obtainable, in addition to the statistics which are embodied in the preceding table, giving the production of pig iron by eight leading countries, we submit the following table of the world's production of pig-iron at various periods since the close of the last century.

*The world's production of pig-iron.*

| Years. | Long tons. | Years. | Long tons. | Years. | Long tons. |
|---|---|---|---|---|---|
| 1800 | 825,000 | 1870 | 11,900,000 | 1879 | 13,950,000 |
| 1830 | 1,825,000 | 1871 | 12,500,000 | 1880 | 17,950,000 |
| 1850 | 4,750,000 | 1872 | 13,925,000 | 1881 | 19,400,000 |
| 1856 | 7,000,000 | 1873 | 14,675,000 | 1882 | 20,750,000 |
| 1865 | 9,250,000 | 1874 | 13,500,000 | 1883 | 21,000,000 |
| 1866 | 9,300,000 | 1875 | 13,675,000 | 1884 | 19,475,000 |
| 1867 | 9,850,000 | 1876 | 13,475,000 | 1885 | 19,100,000 |
| 1868 | 10,400,000 | 1877 | 13,675,000 | | |
| 1869 | 11,575,000 | 1878 | 13,925,000 | | |

With this table before us the growth of the world's pig-iron industry within recent years is seen to have been really wonderful. As this industry grew all other branches of the manufacture of iron and steel have also grown. The extraordinary demands by the railroads of the world and the invention of the Bessemer steel process were the chief causes of this remarkable progress, but there were other causes which should not be overlooked. After our civil war there was a great industrial awakening in this country, beginning in 1865, and after the Franco-German war of 1870 there was a similar awakening in France and Germany, but especially in the latter country. This industrial activity, which largely increased the demand for iron and steel, affected the world's iron and steel industries in a marked degree. The increasing use of iron and steel in ship building, in bridge-building, and for general constructive purposes has also largely increased the demand for both these products. Finally, the American "boom" of 1879 and 1880, following after years of enforced economy in the use of all manufactured articles, gave a fresh and remarkable stimulus to the demand for iron and steel in this country, which the whole world's resources were taxed to supply.

In an address delivered December 10, 1874, at the Continental Hotel, Philadelphia, Hon. Abram S. Hewitt thus referred to the growth of the iron industry in all countries: "In 1856, when the annual production of the world was about 7,000,000 tons, I ventured to predict that the production of iron would reach 14,000,000 tons in 1875. This limit was passed last year, when the product reached 15,000,000 tons. I do not think that I risk my character as a prophet when I indulge the belief that by the close of the present century 25,000,000 tons per annum will be required to supply the wants of man. There are gentlemen in this room who will live to see this prediction verified, for it covers only the life of a single generation." Mr. Hewitt's prediction will probably be verified, but he could scarcely have dreamed when delivering the address from which we have quoted, that long before the close of this century, namely, in 1883, the world's production of pig iron would come so near 25,000,000 tons as it then did. It reached 21,000,000 tons, having more than doubled since 1868.

*Conclusion.*—It has been the object of this paper to exhibit the astonishing progress of the United States in the manufacture of iron and steel in the last twenty-one years, and to show the prominence of our country as a producer of these essential aids to modern civilization. This has been done. It is not necessary to look closely into the future of our iron and steel industries. That they will continue to grow and prosper as the country grows and prospers may be taken for granted. With an abundance of good ores and good fuel, including under the latter head our large stores of natural gas, we must soon become the first iron and steel producing country in the world, as we have long been the largest consumer of these products. Only Great Britain excels us in the production of pig iron and steel, but we annually consume more of each product than our great rival. We consume to-day one-fourth of all the pig iron and one-third of all the steel that the world produces.

## IRON IN THE ROCKY MOUNTAIN DIVISION.

By F. F. Chisolm.

*Colorado.*—With regard to the iron ore deposits of Colorado, there is nothing to be added to the description published on pages 281–285 in the "Mineral Resources" for 1883 and 1884. The low prices of iron products have prevented the consumption of any large quantity of ore. The Colorado Coal and Iron Company is the only producer of iron in the State.

The production of iron ore by the Colorado Coal and Iron Company has been as follows:

*Iron ore mined by the Colorado Coal and Iron Company.*

| Mines. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| South Arkansas | 14,202 | 19,645 | 10,483 | 2,902 |
| Hot Springs | 29,190 | 25,939 | 12,406 | 550 |
| Placer | 8,378 | 1,513 | ..... | ..... |
| Silver Cliff | 854 | ..... | ..... | ..... |
| Grape Creek | 801 | ..... | ..... | ..... |
| Total | 53,425 | 47,097 | 22,889 | 3,452 |

*Wyoming.*—There have been no developments of iron in Wyoming in 1885. The rolling mill at Laramie is operated entirely upon old iron supplied by track renewals of the Union Pacific railway, and its entire product goes to the railway company.

*New Mexico.*—The only iron ore extracted in New Mexico is the comparatively small quantity used in smelting lead ores. No statistics have been obtained of this product.

*Montana.*—While iron ore, in considerable quantities and of fair quality, is known to occur in various parts of Montana, no disposition of it has been attempted anywhere except near Mill Switch, on the Utah and Northern, where there is a good seam of hematite. A considerable quantity of this has been shipped to the Hecla lead smelter at Glendale, and some to the Anaconda smelter and to smelters at Butte. A switch will probably be built up to the mine in 1886, and shipments of the iron ore considerably increased. It is a very desirable ore for fluxing purposes.

## IRON ON THE PACIFIC COAST.

By C. G. Yale.

It was generally supposed a year or so since that the Clipper Gap, Oregon, and Puget Sound furnaces would produce more iron than sufficient for the wants of the Pacific coast, as they have the capacity and the material; but they cannot market their products satisfactorily when American iron at $21.50 and Scotch at $22.50 are competitors.

The Clipper Gap furnace, belonging to the California Iron and Steel Company, was idle during most of 1885, the city supplies having been obtained chiefly from the company's accumulated stocks, which only amounted to 1,000 tons at the end of the year. The company sent 1,200 tons of iron to San Francisco in 1885.

The following statistics from J. W. Hamson's annual circular will give an idea of the iron business in San Francisco during 1885 and preceding years. The circular is dated January 1, 1886.

*Consumption, price, imports, &c., of pig iron at San Francisco.*

| Year. | Quality. | Stock December 31. | Consumption. | Importations. | Lowest and highest prices. | Afloat December 31. |
|---|---|---|---|---|---|---|
| | | *Tons.* | *Tons.* | *Tons.* | *Per ton.* | *Tons.* |
| 1881 | White | 315 | 1,659 | 300 | $24.50 to $30.00 | 2,877 |
| | Soft | 7,960 | 13,518 | 8,302 | | |
| | Total | 8,275 | 15,187 | 8,602 | | |
| 1882 | White | 828 | 989 | 1,502 | 28.00 to 35.00 | 4,337 |
| | Soft | 7,280 | 19,170 | 18,491 | | |
| | Total | 8,108 | 20,159 | 19,993 | | |
| 1883 | White | 1,490 | 1,176 | 1,838 | 24.50 to 27.50 | 1,615 |
| | Soft | 14,548 | 20,674 | 23,142 | | |
| | Total | 16,038 | 21,850 | 24,980 | | |
| 1884 | White | 359 | 1,596 | 465 | 22.00 to 26.00 | 4,230 |
| | Soft | 16,505 | 10,263 | 12,220 | | |
| | Total | 16,864 | 11,859 | 12,685 | | |
| 1885 | White | 693 | 661 | 995 | 21.50 to 23.50 | 3,204 |
| | Soft | 12,796 | 15,581 | 11,872 | | |
| | Total | 13,486 | 16,242 | 12,867 | | |
| Average for the past five years. | White | 737 | 1,216 | 1,020 | 26.25 | 3,252 |
| | Soft | 11,817 | 15,841 | 14,805 | | |
| | Total | 12,554 | 17,057 | 15,825 | | |

The above figures show the stock on hand to be 3,375 tons less than last year at this time, yet 935 tons greater than the average stock for the past five years at this time. The stock on hand and *en route*, together with the promised output of the Clipper Gap furnace for the next six months, insures consumers against any scarcity in the near future.

The present stock on hand consists of 13,489 tons, of which 8,150 tons are British, and 5,339 tons Eastern and home manufacture. There are 3,943 tons in first hands, and 9,546 tons among consumers.

The total importation of wrought scrap iron in 1885 at San Francisco was 9,567 tons, of which 5,557 tons came from Great Britain.

*California.*—The Clipper Gap furnace, at Hotaling, Placer county, California, was not in blast from October, 1884, until February 1, 1886. An immense quantity of charcoal was made in 1885, while the furnace was idle, waiting for prices of iron to advance, and it was decided to

utilize this, otherwise the furnace might have remained cold for some time longer. There is a fine body of ore, plenty of timber for charcoal, and the best plant in the western country, but low prices of product have prevented successful work. The *Placer Republican* thus describes the mine and works:

"Ever since the reorganization of the company in January, 1882, a series of interruptions has interfered with the production. A fire destroyed almost everything at the works in the fall of that year. New machinery was put in and they went into blast in May, 1883. The furnace was kept going until November, when it was shut down until May, 1884. During that time a large, improved blowing engine was put in and the last run before the present season continued from May until October, 1884.

"The company owns between 8,000 and 9,000 acres of land, the bulk of which is in Nevada county. Only about two sections are in Placer. Much of this land can be classed among the best fruit land in the foothills. The managers of the company have received numberless applications from those who wish to take the lands for fruit culture, but they are not disposed to part with their possessions at present, even when the timber is off, because they are strong believers in the steady increase of the value of the property for agricultural purposes. There are five batteries of kilns located at convenient places, aggregating thirty kilns, but these are idle and probably will be for some time. When the furnace went into blast (in February, 1886) there were 400,000 bushels of charcoal on hand, and 500 cords of wood had been hauled to the works, or enough wood to make 20,000 bushels more. When the furnace is running at full blast of between thirty and forty tons a day, the daily consumption of charcoal is about 4,000 bushels, but the furnace is not now being charged to anything like its full capacity.

"There are at present 28,000 cords of wood cut in Nevada county, which is altogether too large a stock to have on hand, and a sale of it to the railroad company is being negotiated for fear that it will deteriorate in quality before it will be needed for charcoal. There were also 4,500 tons of ore mined as a beginning, and twenty or twenty-five men at the mine can take out ore as fast as it can be used. Four shafts have been prospected during the past three or four years, but the one known as shaft No. 2. is the main-stay. It is only about half a mile from the furnace and has been worked to a depth of 128 feet. The character of the ore is magnetic, while limonite is found in some of the other shafts.

"The outlook of the business at this date (February 10, 1886) is not particularly encouraging. Iron that sold in San Francisco for $32 to $35 a ton in the spring of 1884 now finds a slow sale in that market at $22, which will not cover more than the cost of production. The market is unusually dull, owing to the unprecedented stand-still in the manufacture of mining machinery. The little iron that is being used is cheap

coke iron brought from the East, which can be laid down in San Francisco for $20 a ton. The most of it comes from Philadelphia as ballast at as low figures as $3 to $3.20 a ton, while it costs all of $3 a ton to transport pig iron from Hotaling to San Francisco. Another reason for the dull market is the fact that so little is being done in the railroad shops at Sacramento. When busy, the railroad company is a good buyer of Hotaling iron, using it almost exclusively in the manufacture of car wheels. Until recently between two and three thousand tons of pig iron a year have been sold to the railroad for that purpose. "On the other hand, business men discern what they call signs of a little 'better feeling' in the iron trade."

*Oregon.*—The Oregon Iron and Steel Company's furnace, at Oswego, near Portland, Oregon, is now out of blast, and there is no prospect of its starting up for some time. The furnace produced 1,950 tons of iron in 1885.

*Washington Territory.*—The only other smelting furnace on the Pacific coast is near Port Townsend, and belongs to the Puget Sound Iron Company. The furnace continues out of blast, though it is stated that it will before long be started up once more by capitalists who intend to work the mines extensively.

*Idaho.*—No iron was marketed in Idaho during 1885, though some ore was mined at Wood river for home consumption at the smelting works.

*Utah.*—The great iron fields of Utah, located in Iron county, in the southern part of the territory, were looked over by capitalists and experts early in the year 1885, with a view to establishing works there. The iron ore, which exists in large quantity, was deemed ample and the quality good, while an abundance of coal was found accessible thirty-five miles distant; but the quality of this fuel was such as to render its use in the reduction of the ores impracticable. Hence nothing was done, and the development of these iron fields awaits the time when the hard coals of Colorado can be transported by rail. The only iron ore mined during the year in Utah was at Ironton, Juab county, the entire product amounting to 9,720 tons, which was shipped to the Salt Lake smelters and used as a flux in the reduction of argentiferous lead ores. It is mined, shipped by rail a distance of 65 miles, and sold at $4.50 per ton at the smelting works, which consumed also 1,000 tons of iron ore from Colorado.

# GOLD AND SILVER.

*Mint statistics.*—The total production of gold and silver during 1885 has been estimated by Dr. James P. Kimball, Director of the Mint, at $83,401,000, an increase of $3,801,000 above the estimate for the preceding year by Mr. Burchard. The production of gold was $31,801,000, an increase of $1,001,000 over the estimate for 1884. The production of silver, calculated at the coining rate in silver dollars, is estimated at $51,600,000 against $48,800,000 in 1884, an increase of $2,800,000. This estimated increase in the production of precious metals during 1885 is rendered more probable by the increase shown in the estimates by other persons, notably that of Mr. J. J. Valentine, vice-president and general manager of Wells, Fargo & Co., to which reference will be made farther on. The production of gold and silver for the past five years, together with its distribution through the various States and Territories, is given below. The estimates previous to 1885 are those of Hon. Horatio C. Burchard, lately Director of the Mint.

*Production of gold and silver in the United States during the calendar years* 1881 *to* 1885, *inclusive.*

| States and Territories. | 1881. | | | 1882. | | |
|---|---|---|---|---|---|---|
| | Gold. | Silver. | Total. | Gold. | Silver. | Total. |
| Alaska | $15,000 | | $15,000 | $150,000 | | $150,000 |
| Arizona | 1,060,000 | $7,300,000 | 8,360,000 | 1,065,000 | $7,500,000 | 8,565,000 |
| California | 18,200,000 | 750,000 | 18,950,000 | 16,800,000 | 845,000 | 17,645,000 |
| Colorado | 3,300,000 | 17,160,000 | 20,460,000 | 3,360,000 | 16,500,000 | 19,860,000 |
| Dakota | 4,000,000 | 70,000 | 4,070,000 | 3,300,000 | 175,000 | 3,475,000 |
| Georgia | 125,000 | | 125,000 | 250,000 | | 250,000 |
| Idaho | 1,700,000 | 1,300,000 | 3,000,000 | 1,500,000 | 2,000,000 | 3,500,000 |
| Maine | | 5,000 | 5,000 | | | |
| Montana | 2,330,000 | 2,630,000 | 4,960,000 | 2,550,000 | 4,370,000 | 6,920,000 |
| Nevada | 2,250,000 | 7,060,000 | 9,310,000 | 2,000,000 | 6,750,000 | 8,750,000 |
| New Mexico | 185,000 | 275,000 | 460,000 | 150,000 | 1,800,000 | 1,950,000 |
| North Carolina | 115,000 | | 115,000 | 190,000 | 25,000 | 215,000 |
| Oregon | 1,100,000 | 50,000 | 1,150,000 | 830,000 | 35,000 | 865,000 |
| South Carolina | 35,000 | | 35,000 | 25,000 | | 25,000 |
| Tennessee | 5,000 | | 5,000 | | | |
| Utah | 145,000 | 6,400,000 | 6,545,000 | 190,000 | 6,800,000 | 6,990,000 |
| Virginia | 10,000 | | 10,000 | 15,000 | | 15,000 |
| Washington | 120,000 | | 120,000 | 120,000 | | 120,000 |
| Wyoming | 5,000 | | 5,000 | 5,000 | | 5,000 |
| Total | 34,700,000 | 43,000,000 | 77,700,000 | 32,500,000 | 46,800,000 | 79,300,000 |

*Production of gold and silver in the United States, &c.*—Continued.

| | 1883. | | | 1884. | | |
|---|---|---|---|---|---|---|
| Alaska | $300,000 | ..... | $300,000 | $200,000 | ..... | $200,000 |
| Arizona | 950,000 | $5,200,000 | 6,150,000 | 930,000 | $4,500,000 | 5,430,000 |
| California | 14,120,000 | 1,460,000 | 15,580,000 | 13,600,000 | 3,000,000 | 16,600,000 |
| Colorado | 4,100,000 | 17,370,000 | 21,470,000 | 4,250,000 | 16,000,000 | 20,250,000 |
| Dakota | 3,200,000 | 150,000 | 3,350,000 | 3,300,000 | 150,000 | 3,450,000 |
| Georgia | 199,000 | 1,000 | 200,000 | 137,000 | ..... | 137,000 |
| Idaho | 1,400,000 | 2,100,000 | 3,500,000 | 1,250,000 | 2,720,000 | 3,970,000 |
| Montana | 1,800,000 | 6,000,000 | 7,800,000 | 2,170,000 | 7,000,000 | 9,170,000 |
| Nevada | 2,520,000 | 5,430,000 | 7,950,000 | 3,500,000 | 5,600,000 | 9,100,000 |
| New Mexico | 280,000 | 2,845,000 | 3,125,000 | 300,000 | 3,000,000 | 3,300,000 |
| North Carolina | 167,000 | 3,000 | 170,000 | 157,000 | 3,500 | 160,500 |
| Oregon | 660,000 | 20,000 | 680,000 | 660,000 | 20,000 | 680,000 |
| South Carolina | 56,500 | 500 | 57,000 | 57,000 | 500 | 57,500 |
| Utah | 140,000 | 5,620,000 | 5,760,000 | 120,000 | 6,800,000 | 6,920,000 |
| Virginia | 6,000 | ..... | 6,000 | 2,000 | ..... | 2,000 |
| Washington | 80,000 | 500 | 80,500 | 85,000 | 1,000 | 86,000 |
| Wyoming | 4,000 | ..... | 4,000 | 6,000 | ..... | 6,000 |
| Other | 17,500 | ..... | 17,500 | 76,000 | 5,000 | 81,000 |
| Total | 30,000,000 | 46,200,000 | 76,200,000 | 30,800,000 | 48,800,000 | 79,600,000 |

| | 1885. | | |
|---|---|---|---|
| Alaska | $300,000 | $2,000 | $302,000 |
| Arizona | 880,000 | 3,800,000 | 4,680,000 |
| California | 12,700,000 | 2,500,000 | 15,200,000 |
| Colorado | 4,200,000 | 15,800,000 | 20,000,000 |
| Dakota | 3,200,000 | 100,000 | 3,300,000 |
| Georgia | 136,000 | ..... | 136,000 |
| Idaho | 1,800,000 | 3,500,000 | 5,300,000 |
| Montana | 3,300,000 | 10,060,000 | 13,360,000 |
| Nevada | 3,100,000 | 6,000,000 | 9,100,000 |
| New Mexico | 800,000 | 3,000,000 | 3,800,000 |
| North Carolina | 152,000 | 3,000 | 155,000 |
| Oregon | 800,000 | 10,000 | 810,000 |
| South Carolina | 43,000 | ..... | 43,000 |
| Utah | 180,000 | 6,750,000 | 6,930,000 |
| Washington | 120,000 | 70,000 | 190,000 |
| Texas, Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming | 90,000 | 5,000 | 95,000 |
| Total | 31,801,000 | 51,600,000 | 83,401,000 |

*Rank of the States and Territories in the production of gold and silver in* 1883.

| Gold. | Silver. | Total. |
|---|---|---|
| 1. California. | 1. Colorado. | 1. Colorado. |
| 2. Colorado. | 2. Montana. | 2. California. |
| 3. Dakota. | 3. Utah. | 3. Nevada. |
| 4. Nevada. | 4. Nevada. | 4. Montana. |
| 5. Montana. | 5. Arizona. | 5. Arizona. |
| 6. Idaho. | 6. New Mexico. | 6. Utah. |
| 7. Arizona. | 7. Idaho. | 7. Idaho. |
| 8. Oregon. | 8. California. | 8. Dakota. |
| 9. Alaska. | 9. Dakota. | 9. New Mexico. |
| 10. New Mexico. | 10. Oregon. | 10. Oregon. |
| 11. Georgia. | 11. North Carolina. | 11. Alaska. |
| 12. North Carolina. | 12. Georgia. | 12. Georgia. |
| 13. Utah. | 13. { Washington. South Carolina. | 13. North Carolina. |
| 14. Washington. | | 14. Washington. |
| 15. South Carolina. | | 15. South Carolina. |
| 16. "Other." | | 16. "Other." |
| 17. Virginia. | | 17. Virginia. |
| 18. Wyoming. | | 18. Wyoming. |

*Rank of the States and Territories in the production of gold and silver in* 1884.

| Gold. | Silver. | Total. |
|---|---|---|
| 1. California. | 1. Colorado. | 1. Colorado. |
| 2. Colorado. | 2. Montana. | 2. California. |
| 3. Nevada. | 3. Utah. | 3. Montana. |
| 4. Dakota. | 4. Nevada. | 4. Nevada. |
| 5. Montana. | 5. Arizona. | 5. Utah. |
| 6. Idaho. | 6. California. New Mexico. | 6. Arizona. |
| 7. Arizona. | 8. Idaho. | 7. Idaho. |
| 8. Oregon. | 9. Dakota. | 8. Dakota. |
| 9. New Mexico. | 10. Oregon. | 9. New Mexico. |
| 10. Alaska. | 11. "Other." | 10. Oregon. |
| 11. North Carolina. | 12. North Carolina. | 11. Alaska. |
| 12. Georgia. | 13. Washington. | 12. North Carolina. |
| 13. Utah. | 14. South Carolina. | 13. Georgia. |
| 14. Washington. | | 14. Washington. |
| 15. "Other." | | 15. "Other." |
| 16. South Carolina. | | 16. South Carolina. |
| 17. Wyoming. | | 17. Wyoming. |
| 18. Virginia. | | 18. Virginia. |

*Rank of the States and Territories in the production of gold and silver in* 1885.

| Gold. | Silver. | Total. |
|---|---|---|
| 1. California. | 1. Colorado. | 1. Colorado. |
| 2. Colorado. | 2. Montana. | 2. California. |
| 3. Montana. | 3. Utah. | 3. Montana. |
| 4. Dakota. | 4. Nevada. | 4. Nevada. |
| 5. Nevada. | 5. Arizona. | 5. Utah. |
| 6. Idaho. | 6. Idaho. | 6. Idaho. |
| 7. Arizona. | 7. New Mexico. | 7. Arizona. |
| 8. New Mexico. Oregon. | 8. California. | 8. New Mexico. |
| 9. Alaska. | 9. Dakota. | 9. Dakota. |
| 10. Utah. | 10. Washington. | 10. Oregon. |
| 11. North Carolina. | 11. Oregon. | 11. Alaska. |
| 12. Georgia. | 12. "Other." | 12. Washington. |
| 13. Washington. | 13. North Carolina. | 13. North Carolina. |
| 14. "Other." | 14. Alaska. | 14. Georgia. |
| 15. South Carolina. | 15. Wyoming. | 15. "Other." |
| 16. Wyoming. | | 16. South Carolina. |
| 17. Virginia. | | 17. Wyoming. |
| | | 18. Virginia. |

*Mr. Valentine's estimates for* 1885.—Mr. J. J. Valentine, vice-president and general manager of Wells, Fargo & Co., furnishes the following statement of the bullion product of the States and Territories west of the Missouri river, including also British Columbia, and the express receipts from the western coast of Mexico. The table includes the value of lead and copper as well as gold and silver.

*Bullion product of the States and Territories west of the Missouri river in 1885, including the value of base bullion (lead and copper), and also including the partial products of British Columbia and the west coast of Mexico.*

[Estimated by Mr. J. J. Valentine.]

| States and Territories. | Gold dust and bullion by express. | Gold dust and bullion by other conveyances. | Silver bullion by express. | Ores and base bullion by freight. | Total. |
|---|---|---|---|---|---|
| California | $11,750,490 | $587,524 | $1,608,500 | $1,090,158 | $15,036,672 |
| Nevada | 1,253,315 | ..... | 6,575,430 | 1,384,336 | 9,213,121 |
| Oregon | 396,937 | 198,468 | 12,000 | ..... | 607,405 |
| Washington | 72,700 | 36,350 | ..... | ..... | 109,050 |
| Alaska | 215,000 | 20,000 | ..... | 16,000 | 251,000 |
| Idaho | 905,946 | 200,000 | 867,410 | 2,450,000 | 4,423,356 |
| Montana | 2,091,000 | ..... | 6,317,512 | 5,816,000 | 14,224,512 |
| Utah | 33,362 | ..... | 3,061,424 | 5,831,948 | 8,926,734 |
| Colorado | 2,653,000 | ..... | 5,024,000 | 13,695,000 | 21,372,000 |
| New Mexico | 226,519 | 60,000 | 1,107,627 | 2,441,617 | 3,825,763 |
| Arizona | 726,426 | 120,000 | 2,752,068 | 2,996,652 | 6,595,146 |
| Dakota | 2,506,623 | 100,000 | 120,000 | ..... | 2,726,623 |
| Mexico (west coast States) | 287,704 | ..... | 1,953,340 | 20,000 | 2,261,044 |
| British Columbia | 488,834 | 120,000 | ..... | ..... | 608,834 |
| Total | 23,607,896 | 1,442,342 | 29,399,311 | 35,731,711 | 90,181,260 |

The values of the gold, silver, copper, and lead, segregated, were—

| | Per cent. | Value. |
|---|---|---|
| Gold | 30.26 | $27,290,294 |
| Silver | 51.55 | 46,489,939 |
| Copper | 8.69 | 7,838,036 |
| Lead | 9.50 | 8,562,991 |
| Total | ..... | 90,181,260 |

Mr. Valentine has estimated the gold and silver production of the States and Territories west of the Missouri river since 1870, as shown in the following table. The production of British Columbia and the shipments from the west coast of Mexico, and the values of copper and lead have been excluded.

*Mr. Valentine's estimates of the production of gold and silver in the States and Territories west of the Missouri river from 1870 to 1885 inclusive.*

| Years. | Gold. | Silver. | Total. |
|---|---|---|---|
| 1870 | $33,750,000 | $17,320,000 | $51,070,000 |
| 1871 | 34,398,000 | 19,286,000 | 53,684,000 |
| 1872 | 38,177,395 | 19,924,429 | 58,101,824 |
| 1873 | 39,206,558 | 27,483,302 | 66,689,860 |
| 1874 | 38,466,488 | 29,699,122 | 68,165,610 |
| 1875 | 39,968,194 | 31,635,239 | 71,603,433 |
| 1876 | 42,886,915 | 39,292,924 | 82,179,859 |
| 1877 | 44,880,223 | 45,846,109 | 90,726,332 |
| 1878 | 37,576,030 | 37,248,137 | 74,824,167 |
| 1879 | 31,420,262 | 37,032,857 | 68,453,119 |
| 1880 | 32,559,067 | 38,033,055 | 70,592,122 |
| 1881 | 30,653,959 | 42,987,613 | 73,641,572 |
| 1882 | 29,011,318 | 48,133,039 | 77,144,357 |
| 1883 | 27,816,610 | 42,975,101 | 70,791,741 |
| 1884 | 25,183,567 | 43,529,925 | 68,713,492 |
| 1885 | 26,393,756 | 44,516,599 | 70,910,355 |

The apparent discrepancy between the estimates of the Director of the Mint and those of Mr. Valentine are partially explained by the exclusion in the latter estimates of the eastern States, and also by the statement of Mr. Valentine that the facilities afforded for the transportation of bullion, ores, and base metals, by the extension of railroads into mining districts, increase the difficulty of verifying the reports of the products from several important localities; and the general tendency is to exaggeration when the actual values are not obtainable from authentic sources; but the aggregate result may be relied upon with reasonable confidence as approximately correct.

*Total output to date.*—The estimate of the entire production of gold in the United States since 1804, as given in the last report, has been carried forward to include the year 1885 and amounts to $1,708,715,670, the corresponding total for silver is $722,283,217; total yield of both metals equals $2,430,998,887. The following table shows the estimates for previous years:

*Production of gold and silver in the United States to December* 31, 1885.

| Periods. | Gold. | Silver. | Total. |
|---|---|---|---|
| Output of the southern States from 1804 to the discovery of gold in California in 1848 (based on estimates of Prof. J. D. Whitney) | $13,243,475 | ..... | $13,243,475 |
| Product from 1848 to 1879, inclusive, by fiscal years | 1,484,041,532 | $422,722,260 | 1,906,763,792 |
| Fiscal year ending June 30, 1880 (census figures, covering a period one month earlier, assumed) | 33,379,663 | 41,110,957 | 74,490,620 |
| July 1, 1880, to December 31, 1880 (estimated on the basis of half the product of the fiscal year 1881, as reported by Hon. Horatio C. Burchard, Director of the Mint) | 18,250,000 | 21,050,000 | 39,300,000 |
| Calendar years 1881 to 1884, inclusive (as reported by Hon. Horatio C. Burchard, Director of the Mint) | 128,000,000 | 184,800,000 | 312,800,000 |
| Calendar year 1885 (as reported by Dr. James P. Kimball, Director of the Mint) | 31,801,000 | 51,600,000 | 83,401,000 |
| Total product of the United States to close of 1885 | 1,708,715,670 | 722,283,217 | 2,430,998,887 |

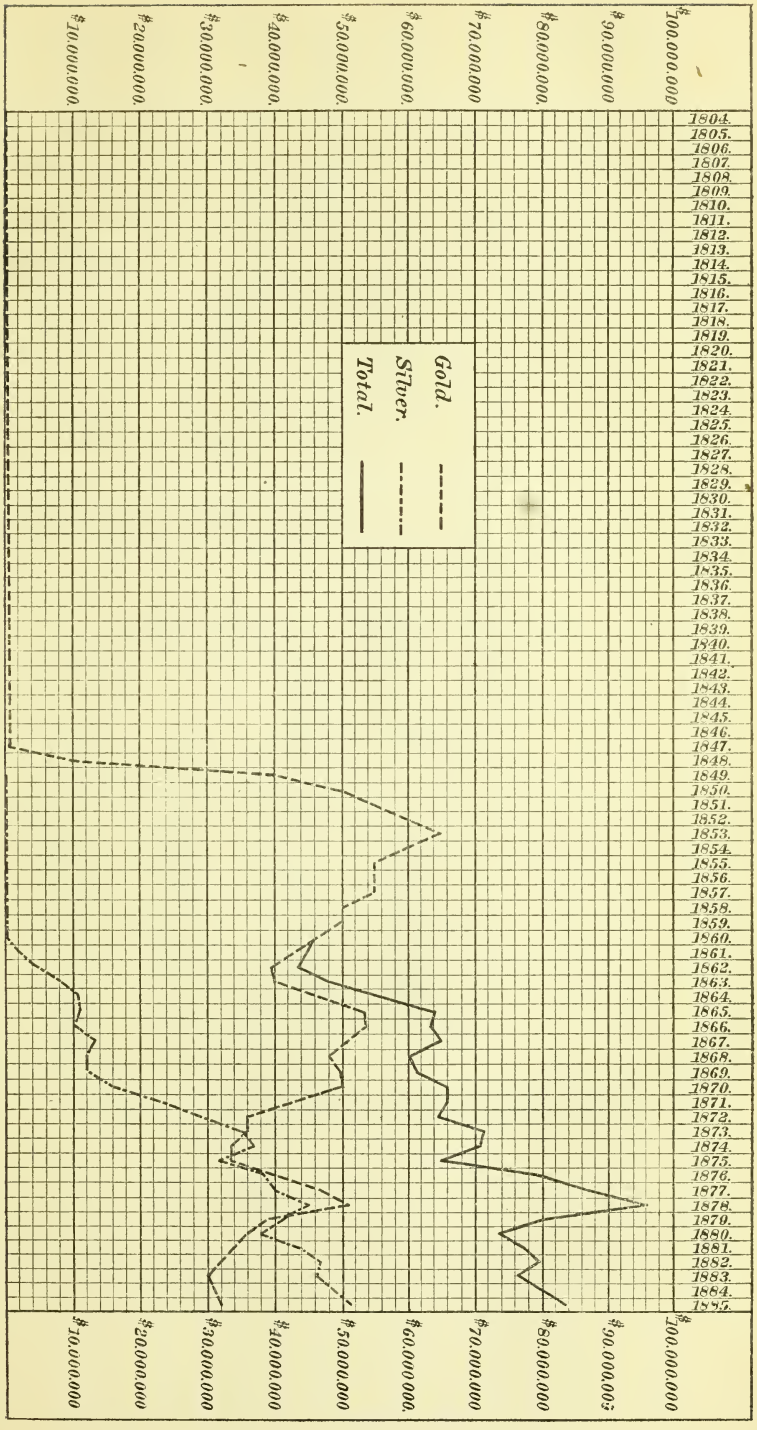


FIG. 2.—PRODUCTION OF GOLD AND SILVER IN THE UNITED STATES TO DECEMBER 31, 1885.

*Consumption in the arts.*—From the returns from 2,700 consumers of gold and silver, Dr. Kimball states the value of gold consumed in the arts to have been $10,837,944 in 1885 against $14,500,000 reported by about the same number of firms in 1884. Of the amount for 1885 about $2,800,000 consisted of United States coin and about $6,000,000 of stamped United States bars. The foreign coin used amounted to $178,000 and old jewelry to $819,000, leaving only $467,000 of native grains and $559,000 of wire and rolled plate. The silver consumption reported by the same firms was $3,470,000 against $5,500,000 in 1884. Of the amount used in 1885, $124,910 consisted of United States coin, $2,773,975 of United States refinery bars, $40,000 of foreign coin, and $219,000 of old jewelry, plate, &c., leaving only $94,000 of native grains and about $217,000 of wire and rolled plate. The total value of gold and silver used in the arts in 1885 was, therefore, $14,307,944.

This leads to the conclusion that either the consumption of gold and silver in the arts has decreased since the previous year, or that there has been less duplication in the returns than heretofore, between original and secondary manufacturers.

*Imports of gold and silver, 1868 to 1885, inclusive.*

| Fiscal years ending June 30— | Gold. | | | Silver. | |
|---|---|---|---|---|---|
| | Dust. (a) | Bullion. | Coin. | Bullion. | Coin. |
| 1868 | ..... | $1,909,503 | $6,558,602 | $151,238 | $5,304,835 |
| 1869 | ..... | 890,064 | 13,240,191 | 54,267 | 5,622,548 |
| 1870 | ..... | 697,904 | 11,452,414 | 161,932 | 14,217,406 |
| 1871 | ..... | 1,177,387 | 5,704,298 | 69,836 | 11,591,875 |
| 1872 | $258,329 | 1,101,617 | 7,339,572 | 405,631 | 4,647,034 |
| 1873 | 7,771 | 1,549,899 | 7,092,011 | 476,608 | 12,318,911 |
| 1874 | 20,842 | 1,349,346 | 18,089,155 | 830,639 | 8,153,087 |
| 1875 | 15,222 | 1,562,767 | 12,018,537 | 1,294,763 | 5,913,474 |
| 1876 | 28,802 | 1,167,102 | 6,596,692 | 1,057,377 | 6,885,795 |
| 1877 | 85,858 | 2,032,997 | 24,131,925 | 4,693,605 | 9,829,666 |
| 1878 | 17,602 | 1,955,005 | 11,365,656 | 6,971,849 | 9,512,704 |
| 1879 | 17,949 | 1,275,749 | 4,373,168 | 2,424,675 | 12,203,871 |
| 1880 | 883,690 | 19,453,755 | 60,420,951 | 1,981,425 | 10,294,489 |
| 1881 | 697,467 | 30,301,452 | 69,032,340 | 2,303,472 | 8,240,766 |
| 1882 | 647,551 | 8,758,502 | 24,971,001 | 2,121,833 | 5,973,603 |
| 1883 | ..... | 3,334,708 | 14,399,441 | 2,475,968 | 8,279,274 |
| 1884 | ..... | 4,997,571 | 17,833,746 | 2,910,451 | 11,684,494 |
| 1885 | ..... | 8,849,237 | 17,842,459 | 4,530,384 | 12,020,243 |

a In 1868–1871, 1883, 1884, and 1885 included under head of gold bullion.

*Exports of gold and silver of domestic production, 1851 to 1885, inclusive.*

| Fiscal years ending June 30— | Gold and silver coin. (b) | Gold. | | Silver. | |
|---|---|---|---|---|---|
| | | Bullion. | Coin. | Bullion. | Coin. |
| 1851 | $18,669,580 | | | | |
| 1852 | 37,437,837 | | | | |
| 1853 | 23,548,535 | | | | |
| 1854 | 38,062,570 | | | | |
| 1855 | 19,842,423 | $34,114,995 | | | |
| 1856 | 15,458,333 | 28,689,946 | | | |
| 1857 | 28,777,372 | 31,300,980 | | | |
| 1858 | 19,474,040 | 22,933,206 | | | |
| 1859 | 24,172,442 | 33,329,863 | | | |
| 1860 | 26,033,678 | 30,913,173 | | | |
| 1861 | 10,488,590 | 13,311,280 | | | |
| 1862 | | 13,267,739 | $17,776,912 | | |
| 1863 | 44,608,529 | 11,385,033 | | | |
| 1864 | | 10,985,703 | 86,148,921 | $836,387 | $2,702,551 |
| 1865 | | 21,145,055 | 35,413,651 | 6,311,986 | 1,747,432 |
| 1866 | | 20,741,473 | 49,395,993 | 10,832,849 | 1,683,059 |
| 1867 | | 13,867,641 | 22,362,025 | 15,853,530 | 2,892,990 |
| 1868 | | 23,841,155 | 44,390,003 | 12,978,311 | 2,536,506 |
| 1869 | | 13,584,497 | 14,858,369 | 13,573,427 | 899,763 |
| 1870 | | 15,812,108 | 12,768,501 | 11,748,864 | 3,554,329 |
| 1871 | | 9,089,959 | 55,491,719 | 17,285,916 | 2,535,765 |
| 1872 | | 7,986,145 | 40,391,357 | 22,729,657 | 1,691,081 |
| 1873 | | 8,810,175 | 35,661,863 | 27,759,066 | 1,674,442 |
| 1874 | | 3,878,543 | 28,766,943 | 22,498,782 | 4,555,418 |
| 1875 | | 2,233,775 | 59,309,770 | 17,197,914 | 5,115,670 |
| 1876 | | 1,888,896 | 27,542,861 | 15,240,344 | 5,366,590 |
| 1877 | | 1,084,536 | 21,274,565 | 11,482,894 | 9,292,743 |
| 1878 | | 205,319 | 6,427,251 | 15,035,045 | 5,394,270 |
| 1879 | | 24,774 | 4,150,311 | 11,883,064 | 1,526,886 |
| 1880 | | 87,066 | 1,687,973 | 6,912,864 | 659,990 |
| 1881 | | 84,943 | 1,741,364 | 11,852,995 | 547,642 |
| 1882 | | 1,598,336 | 29,805,280 | 11,653,547 | 423,099 |
| 1883 | | 4,118,455 | 4,802,454 | 12,551,378 | 150,894 |
| 1884 | | 23,052,183 | 12,242,021 | 14,241,050 | 690,381 |
| 1885 | | 395,750 | 2,345,809 | 20,422,924 | 1,211,627 |

b In 1862 and 1864–1885 segregated, appearing n the other columns.

# COPPER.

## THE COPPER INDUSTRY OF THE UNITED STATES.

By C. Kirchhoff, Jr.

The year 1885 has been the severest yet experienced by the copper trade of the world, the lowest prices for long continued periods having been reached during that year. The market in this country has not followed a course strictly parallel to that in Europe, and therefore the low values of the latter have not affected in the same way the different producing regions of the United States. The reason for this is, that the percentage of the product sent abroad varies within wide limits with the different sections. Montana in 1885 exported the bulk of its produce, the Lake Superior district only a part, and Arizona a small fraction. The decline abroad was largely due to the quantities sent from this country, and to the manner in which the copper was marketed.

At home, after the expiration of the sliding-scale contracts, which carried prices to an unprecedentedly low level, the market rallied and remained fairly steady during the year at a level considerably above that of European markets.

The effect of the low prices upon the American mines had nearly exhausted itself towards the close of 1884, and there has been very little change in the ranks of the producers during 1885. Some of them realized in an increased output on the preparations made during preceding years; this has been notably the case in the Lake Superior district, and with the Anaconda mine, Butte, Montana, which has kept its large concentrating and smelting plant running the year round on ore extracted during a former period. Some mines, which were able to meet the low prices current, have nevertheless been idle, preferring not to exhaust reserves of rich ore without reaping an adequate profit. Their number, however, has been small. In the beginning of the year the extravagant claims in behalf of a newly-discovered district in the southwest gave rise to some uneasiness, not unnatural since the recent experience with so suddenly overwhelming a competitor as Montana. The trade has learned to become very sensitive on this subject, but neither the Texas deposits nor those of Lower California will in the near future play any important part in shaping the course of the metal.

How far reductions in cost have compensated for the decline in receipts per pound of product it is difficult to ascertain, so far as the producers generally are concerned. In the Lake Superior district the

reports of a number of public companies throw sufficient light on the subject. In the Arizona mines there has been some relief in the way of lower freights on fuel and product, and the same may be stated so far as the Montana producers are concerned. The latter are still handicapped by high labor. The majority of the mines of the Rocky mountains are now in the hands of individual firms or of close corporations so that it is impossible to state what, if any, their profits or losses have been. The dividends paid by public companies during 1885 compare as follows with the profits paid out in previous years:

*Dividends of copper mining companies..*

| Name of mine. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|
| Calumet and Hecla (Lake Superior) | $2,000,000 | $2,000,000 | $1,300,000 | $1,700,000 |
| Quincy (Lake Superior) | 440,000 | 380,000 | 280,000 | 180,000 |
| Osceola (Lake Superior) | 200,000 | 200,000 | 62,500 | ..... |
| Atlantic (Lake Superior) | 80,000 | 80,000 | 40,000 | 20,000 |
| Central (Lake Superior) | 60,000 | 60,000 | 40,000 | *a* 30,000 |
| Franklin (Lake Superior) | ..... | 80,000 | 80,000 | 40,000 |
| Copper Queen (Arizona) | 325,000 | 500,000 | 200,000 | ..... |
| San Francisco (California) | ..... | 2,500 | ..... | ..... |
| United Verde (Arizona) | ..... | 37,500 | 60,000 | ..... |

*a* By sale of timber lands.

It should be stated that some of the Lake Superior mining companies declare their dividends in the beginning of the year out of the earnings of the year before, so that the date of the dividend does not in some cases reflect the earning capacity of the mine in that year.

There has been much less difficulty during the current year than in the past in collecting full statistics. Absolute accuracy is not claimed, nor is it attainable, where the producers themselves often do not know to a pound what their output has been. This applies particularly to some of the Montana mines whose product goes abroad for treatment. As in former years, the refining works have sent full, confidential returns showing the source of the copper handled by them, information which affords a valuable guide in other directions, to be discussed further on.

## DOMESTIC PRODUCTION.

The growth in the production of copper in the United States, compiled up to 1885, inclusive, from the best data available, is shown in the following table. It proves in a striking manner how preponderating was, until the past few years, the influence of the Lake Superior district; and again of one great mine in it, the Calumet and Hecla, for more than a decade. In order to point out more clearly how preponderating has been the output of the Lake district from 1867 to 1880, a column has been added giving its percentage of the total product from year to year. It should be stated that the yield of copper from pyrites is not here included.

*Production of copper in the United States from* 1845 *to* 1885, *inclusive.*

| Years. | Total production. | Lake Superior. | Calumet and Hecla. | Percentage of Lake Superior of total product. | Years. | Total production. | Lake Superior. | Calumet and Hecla. | Percentage of Lake Superior of total product. |
|---|---|---|---|---|---|---|---|---|---|
| | *Longtons.* | *Longtons.* | *Longtons.* | | | *Longtons.* | *Longtons.* | *Longtons.* | |
| 1845... | 100 | 12 | ..... | 12.0 | 1866... | 8,900 | 6,138 | ..... | 68.8 |
| 1846... | 150 | 26 | ..... | 17.0 | 1867... | 10,000 | 7,824 | 603 | 78.2 |
| 1847... | 300 | 213 | ..... | 71.0 | 1868... | 11,600 | 9,346 | 2,276 | 80.6 |
| 1848... | 500 | 461 | ..... | 92.5 | 1869... | 12,500 | 11,886 | 5,497 | 95.1 |
| 1849... | 700 | 672 | ..... | 96.0 | 1870... | 12,600 | 10,992 | 6,277 | 87.2 |
| 1850... | 650 | 572 | ..... | 88.0 | 1871... | 13,000 | 11,942 | 7,242 | 91.9 |
| 1851... | 900 | 779 | ..... | 86.6 | 1872... | 12,500 | 10,961 | 7,215 | 95.7 |
| 1852... | 1,100 | 792 | ..... | 72.0 | 1873... | 15,500 | 13,433 | 8,414 | 87.3 |
| 1853... | 2,000 | 1,297 | ..... | 64.9 | 1874... | 17,500 | 15,327 | 8,984 | 87.6 |
| 1854... | 2,250 | 1,819 | ..... | 71.1 | 1875... | 18,000 | 16,089 | 9,586 | 89.4 |
| 1855... | 3,000 | 2,593 | ..... | 86.4 | 1876... | 19,000 | 17,085 | 9,683 | 88.9 |
| 1856... | 4,000 | 3,666 | ..... | 91.6 | 1877... | 21,000 | 17,422 | 10,075 | 82.9 |
| 1857... | 4,800 | 4,255 | ..... | 88.7 | 1878... | 21,500 | 17,719 | 11,272 | 82.4 |
| 1858... | 5,500 | 4,088 | ..... | 74.3 | 1879... | 23,000 | 19,129 | 11,728 | 83.2 |
| 1859... | 6,300 | 3,985 | ..... | 63.3 | 1880... | 27,000 | 22,204 | 14,140 | 82.2 |
| 1860... | 7,200 | 5,388 | ..... | 74.8 | 1881... | 32,000 | 24,363 | 14,000 | 76.1 |
| 1861... | 7,500 | 6,713 | ..... | 89.1 | 1882... | 40,467 | 25,439 | 14,309 | 62.1 |
| 1862... | 9,000 | 6,065 | ..... | 67.4 | 1883... | 51,574 | 26,653 | 14,788 | 50.1 |
| 1863... | 8,500 | 5,787 | ..... | 67.0 | 1884... | 63,555 | 30,916 | 17,812 | 48.4 |
| 1864... | 8,000 | 5,576 | ..... | 69.7 | 1885... | 74,053 | 32,206 | 21,093 | 43.5 |
| 1865... | 8,500 | 6,410 | ..... | 75.4 | | | | | |

Territorially distributed the production of the United States in 1885 has been as follows, as compared with previous years. For 1884 some modifications have been made in some of the figures, since official returns have been obtained in a few instances which were refused a year since:

*Total copper production in the United States in* 1882, 1883, 1884, *and* 1885.

| Source. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* |
| Lake Superior | 56,982,765 | 59,702,404 | 69,353,202 | 72,148,172 |
| Arizona | 17,984,415 | 23,874,963 | 26,734,345 | 22,706,366 |
| Montana | 9,058,284 | 24,664,346 | 43,093,054 | 67,797,864 |
| New Mexico | 869,498 | 823,511 | 59,450 | 79,839 |
| California | 826,695 | 1,600,862 | 876,166 | 469,028 |
| Colorado | 1,494,000 | 1,152,652 | 2,013,125 | 1,146,460 |
| Utah | 605,880 | 341,885 | 265,526 | 126,199 |
| Wyoming | 100,000 | 962,468 | ..... | ..... |
| Nevada | 350,000 | 288,077 | 100,000 | 8,871 |
| Idaho | ..... | ..... | 46,667 | 40,381 |
| Missouri | 294,695 | 260,306 | 230,000 | ..... |
| Maine and New Hampshire | 290,000 | 212,124 | 249,018 | 211,602 |
| Vermont | 1,265,000 | 400,000 | 655,405 | |
| Southern States | 400,000 | 395,175 | 317,711 | 40,199 |
| Middle States | ..... | 64,400 | 2,114 | 190,641 |
| Lead desilverizers, &c | 125,000 | 782,880 | 950,870 | 910,144 |
| Total domestic copper | 90,646,252 | 115,526,053 | 144,946,653 | 165,875,766 |
| From imported pyrites and ores | 1,000,000 | 1,625,742 | 2,858,754 | 5,086,841 |
| Total including copper from imported pyrites | 91,646,232 | 117,151,795 | 147,805,407 | 170,962,607 |

The Montana product this year is compiled from official returns from all the largest producers, only small mines being missing. As the bulk of this product goes to the works of the larger producers by purchase of ores and concentrates, only a small error can have been made by estimating the copper contents of the ore and concentrate shipments made to foreign countries.

The following is, in detail, the output of the Lake Superior mines. In the majority of cases it is the official product, based on smelting-works returns; in a few instances it is an official estimate of the ingot product based on the known output of mineral. The Mass is the only larger mine in the case of which the ingot was estimated from the published statement of the output of mineral. The total is accurate, therefore, within a few thousand pounds.

*The production of Lake Superior copper mines, 1880 to 1885.*

| Mines. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Calumet and Hecla | 31,675,239 | 31,360,781 | 32,053,039 | 33,125,045 | 40,473,585 | 47,247,990 |
| Quincy | 3,696,263 | 5,506,848 | 5,665,796 | 6,012,239 | 5,650,436 | 5,848,530 |
| Osceola | 3,383,537 | 4,179,976 | 4,176,782 | 4,256,409 | 4,247,630 | 1,945,208 |
| Franklin | 2,336,466 | 2,677,932 | 3,264,120 | 3,488,708 | 3,748,652 | 4,007,105 |
| Allouez | 1,318,471 | 1,473,007 | 1,683,557 | 1,751,377 | 1,928,174 | 2,170,476 |
| Atlantic | 2,341,195 | 2,528,009 | 2,631,708 | 2,682,197 | 3,163,585 | 3,582,633 |
| Pewabic | 970,509 | 1,876,244 | 1,482,666 | 1,171,847 | 227,834 | ..... |
| Central | 2,026,078 | 1,418,465 | 1,353,597 | 1,268,556 | 1,446,747 | 2,157,408 |
| Grand Portage | 67,860 | 26,264 | 757,080 | 735,598 | 255,860 | ..... |
| Conglomerate | 233,814 | 386,091 | 734,249 | 222,117 | 1,198,691 | ..... |
| Mass | 517,159 | 467,684 | 737,440 | 659,474 | 481,396 | 365,000 |
| Copper Falls | 6,615 | 669,121 | 587,500 | 804,000 | 891,168 | 1,168,000 |
| Phœnix | 436,010 | 409,357 | 537,177 | 512,291 | 631,004 | 344,355 |
| Hancock | 3,032 | 571,897 | 540,575 | 484,906 | 562,636 | 203,037 |
| Huron | 70,285 | 254,515 | 364,579 | 720,213 | 1,927,660 | 2,252,484 |
| Ridge | 223,353 | 235,606 | 102,936 | 60,155 | 74,030 | 63,390 |
| Saint Clair | 13,195 | 135,493 | 87,126 | 125,225 | 139,407 | ..... |
| Cliff | 78,962 | 79,382 | 66,053 | 10,374 | 28,225 | ..... |
| Wolverine | ..... | ..... | 25,623 | 699,622 | 751,763 | 328,610 |
| Nonesuch | 55,584 | 119,061 | 46,450 | ..... | 23,867 | 28,484 |
| Isle Royal | 79,469 | 47,308 | 35,447 | ..... | 16,074 | ..... |
| Minong | 27,407 | 15,397 | 21,380 | 3,582 | ..... | ..... |
| National | ..... | ..... | 17,060 | 26,006 | 87,368 | 162,252 |
| Minesota | 26,033 | 24,227 | 10,672 | 6,226 | 1,144 | 12,608 |
| Belt | ..... | ..... | 5,625 | 16,402 | 130,851 | 27,433 |
| Sheldon and Columbia | 26,931 | 10,031 | 3,299 | ..... | 9,828 | ..... |
| Aztec | 3,757 | ..... | 3,129 | ..... | ..... | ..... |
| Adventure | 2,951 | 7,500 | 429 | ..... | 4,333 | 4,000 |
| Peninsula | ..... | ..... | ..... | 849,400 | 1,225,981 | ..... |
| Tamarack | ..... | ..... | ..... | 7,435 | ..... | 181,669 |
| Ogima | 5,885 | 16,776 | 4,207 | 3,000 | 1,106 | 12,000 |
| Concord | 10,464 | 28,849 | ..... | ..... | ..... | ..... |
| Evergreen Bluff | 10,651 | 968 | ..... | ..... | 954 | 1,500 |
| Flint Steel River | 28,080 | 4,140 | ..... | ..... | ..... | ..... |
| Madison | ..... | 1,534 | ..... | ..... | ..... | ..... |
| Northwestern | 916 | ..... | ..... | ..... | ..... | ..... |
| Ash Bed | ..... | 24,804 | 72,636 | ..... | 1,517 | ..... |
| Centennial | ..... | ..... | 83,554 | ..... | ..... | ..... |
| Sundry companies—tributers | 6,166 | 1,642 | ..... | ..... | 21,696 | 34,000 |
| Total | 49,682,337 | 54,548,909 | 57,155,991 | 59,702,404 | 69,353,202 | 72,148,172 |

The figures given under "lead desilverizers" in the general table is the closest approximation obtainable by a study of the returns from the lead-desilverizing works, who usually report to this office separately their make of bluestone and of matte. The total stated under "imported pyrites and ores" may include some copper from domestic pyrites, since it is impossible to separate them in some cases. It may be stated, however, that fully 4,000,000 pounds can be traced to a foreign source directly.

### THE COPPER DISTRICTS OF THE UNITED STATES.

*Lake Superior.*—The low prices reached in the first months of the year 1885 forced a suspension of operations at a number of the smaller mines and of concerns who by recent heavy capital outlays had exhausted

their resources. Some of these were turned over to the tender mercies of tributers. The higher prices realized during the second part of the year have given encouragement, and a few older producers, practically idle for years, are again taken in hand. So far as the large corporations are concerned, the preparations for increased output made in 1884 and partly in 1885, the strict economy exercised in every department, and the moderate decline in fuel, supplies, and other costs have made it possible to effect a saving in the figures at which the metal can be put into eastern markets. The following table gives the cost of production of the principal mines in the years 1875, 1881, 1882, 1883, 1884, and 1885:

*Cost of production of lake copper per pound.*

| Mines. | Cost of production (in cents per pound). | | | | | | Yield (per cent.). | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1885. | 1884. | 1883. | 1882. | 1881. | 1875. | 1885. | 1884. | 1883. | 1882. | 1881. | 1875. |
| Quincy | 7.50 | 8.63 | 9.00 | 9.55 | 10.03 | 15.79 | 2.51 | 2.70 | 2.86 | 3.21 | 2.62 | ..... |
| Osceola | 10.90 | 11.24 | 12.21 | 12.97 | ..... | ..... | ..... | 1.17 | 1.21 | ..... | 1.29 | ..... |
| Atlantic | 9.37 | 10.88 | 12.56 | 13.80 | 13.68 | 22.12 | .74 | .75 | .68 | .69 | .72 | .78 |
| Central | 8.83 | 15.10 | 15.40 | 14.76 | 14.24 | 15.81 | 3.37 | 2.48 | 1.90 | 2.20 | 1.58 | 2.65 |
| Allouez | 11.29 | 13.46 | 15.98 | 17.38 | 19.32 | ..... | .84 | .85 | .86 | .85 | .95 | ..... |
| Franklin | 10.03 | 11.62 | 12.96 | 13.00 | ..... | ..... | 1.46 | 1.45 | 1.38 | 1.10 | ..... | ..... |
| Pewabic | ..... | ..... | 21.47 | 17.00 | 16.36 | ..... | ..... | ..... | 1.01 | 1.00 | 1.38 | ..... |
| Huron | 11.75 | 14.78 | ..... | ..... | ..... | ..... | 1.18 | 1.45 | ..... | ..... | ..... | ..... |

This record is one of which the Lake Superior copper companies may well be proud. It should be noted that the Osceola Company was under heavy outlays for a part of the time, and did not crush more than a part of the year. It is more than likely that its cost, with cheaper transportation of rock from mine to mill, will be considerably lowered during this year.

At the Calumet and Hecla mine the work of replacing the Ball by Leavitt stamps was continued during the year, and the summer of 1886 will witness the completion of the equipment for twelve of the Leavitt stamps, of which two are to be held in reserve, making the capacity of the mill about 2,500 tons per day. If running exclusively on rock from the Calumet and Hecla mines, and not treating any of the lower-grade ore from the Black Hills ground, the mine would have a capacity of about 64,000,000 to 65,000,000 annually. The Quincy Company has done well during the year, having produced 7,091,805 pounds of mineral, of which 6,604,125 pounds were from stamping 108,181 tons of rock, on which the earnings for the year were $235,653.73, allowing the payment of $240,000 dividends on the year's business.

The Osceola Company took an important step during the year 1885 in moving its mill from Portage Lake, a distance of 12 miles from the mine, to Torch Lake, with which the mine is connected by a new railroad, the Hancock and Calumet railroad. This work, which occupied about six months and cost $64,000, with other construction outlays and the cost of continuing mining work reduced the surplus from

$231,530 to $102,282, but placed the mine, with nearly an additional year's reserve of productive ground, in the position of making copper more economically. A part of the mill is leased to the Tamarack Company pending the erection of a plant for that new mine, which is largely controlled by the same parties.

The event of the year in the Lake Superior district was the piercing of the Calumet and Hecla lode, on the 20th of June, by the vertical shaft of the Tamarack, at a depth of 2,270 feet. The sinking of the shaft was begun in February, 1882, and, considering the ground, is remarkable as being the most rapid work of its kind; the average monthly progress being 41.4 feet in 1882, 59.7 feet in 1883, 63.4 feet in 1884, and 64 feet in 1885. The average cost of sinking per foot is reported to have been $61, including all expenses. According to the report of Mining Commissioner Lawton, the price paid for sinking in the spring of 1886 was $28 per foot; for cross cutting to the lode, $8; for driving on the conglomerate, $12 to $15; and for stoping, $10 to $14 per cubic fathom. Sinking the shaft is progressing steadily, and in February three levels had been opened. Owing to the fact that the first shaft is located near the corner of the property, the first level develops 224 feet of the lode; the second, 65 feet vertically below it 400 feet; and the third, 57 feet below the second, may develop 2,570 feet of the lode. Ground has been broken for the second shaft 731 feet north of the first. The Tamarack enterprise is a new departure in Lake Superior mining, since it is the first to adopt the system of vertical shafts in the place of numerous inclines. Its advantages are great in permitting of rapid hoisting and large capacity, without heavy outlays for plant, by the use of comparatively small high-speed engines, and in reducing the cost of timbering on the lode to a minimum both in shaft and in stopes. While the greater part of the area of the Tamarack property is so located that those portions of it underlaid by the Calumet and Hecla chute can only be reached at considerably greater depth than that thus far attained, the high grade of the rock and the absence of all serious difficulties to very deep mining open for it a very promising future. The mine is now a regular producer, the company having leased a part of the Osceola mill. It made in December, 1885, 125 tons of mineral; in January, 1886, 174 tons; in February, 200 tons; and in March, 220 tons. Mr. Lawton is authority for the statement that while restricted to the Osceola mill it is not probable that a greater monthly average than 350 tons will be reached. Its product will, however, probably figure prominently in the returns for 1886, and will more than compensate for the falling off in the output of the Osceola, since the rock treated is much higher in grade.

In spite of the fact that the amount of mineral per ton of rock at the Franklin mine fell off from 1.78 per cent. in 1884 to 1.75 per cent. in 1885, the yield of ingot copper rose to 3,999,172 pounds, a gain of 250,520 pounds, produced at a lower cost. The saving amounted to 27 cents

per ton, the cost of mining and manipulating per ton of rock hoisted declining to $1.95. The mill crushed 137,276 tons of rock, a gain of 8,394 tons over 1884, and the management was able to report in the mine, broken and ready for hoisting, 25,000 tons of rock, not valued as an asset. The Huron mine, under energetic and careful management, has come forward rapidly, considering the adverse circumstances, the stamping facilities not being up to the capacity of the mine to furnish rock. Yet the mine shows a gain in output of 331,225 pounds of ingot, while the cost of production has been lowered. The amount of rock hoisted was 139,129 tons, which cost to manipulate it $1.59, a saving of 69 cents over 1884. The stamp mill treated 95,476 tons, the average yield being 1.18 per cent of ingot copper.

The Atlantic mine during the year 1885 has obtained even better results, so far as cost of treatment of rock is concerned, than in former years. With rock yielding only 0.743 per cent. of refined copper, the costs have been as follows per ton of rock treated:

*Cost at the Atlantic mine.*

| | 1885. |
|---|---|
| | *Cents.* |
| Mining, selecting, breaking, and all surface expenses, including taxes | 78.62 |
| Transportation to mill | 4.80 |
| Stamping and separating | 30.36 |
| Freight, smelting, marketing, and New York expenses | 25.45 |
| Total working expenses | 139.23 |
| Total expenditures | 143.60 |
| Net profit | 22.05 |

The Central mine had a comparatively prosperous year, owing to the fact that some of the ground stoped proved more productive, while the costs were little increased. The mine is one of the few of the "mass" mines which have survived. Out of its product of 2,714,840 pounds of mineral in 1885, 1,482,535 pounds were stamp copper, while 1,232,305 pounds were barrel and mass copper. The yield of the stamp copper was 3.37 per cent. on 17,812 tons, crushed and washed at an expense of 74.31 cents per ton, running about half time. The mining profit was $56,642.50 for the year, out of which a dividend of $40,000 was declared on the 1st of February, 1886, the balance being added to surplus, which was carried up to $268,281.88. It is proposed to improve the hoisting facilities during the year 1886, they having become inadequate to handle rock from greater depth. The mine has reached a depth of over 2,000 feet vertically, and the engine now building, of a special design, is intended to meet all requirements to a depth of 3,000 feet.

The Peninsula mine was idle during the greater part of the year, but preparations are to be made to resume work. The Minesota property has passed into the same hands which control the Franklin and the

Huron mines, and it is expected that operations will be more vigorously carried on in the near future.

The Ridge mine was idle during the summer, and its product, 79,137 pounds of mineral, yielding almost 80 per cent. of ingot copper, was obtained by tributers. On the Conglomerate property no work has been done by the company. The Belt has done little during the year.

Reviewing the situation generally, it may be stated that if the leading companies utilize their equipment to its full capacity, the yield of the Lake Superior mines will show a slight increase during 1886. Prices at the beginning of the season, after the opening of spring, while fairly profitable to mines in operation, were not such as to encourage the resumption of idle plants.

*Arizona.*—The output of Arizona has declined during 1885, because prices were too low to allow of the working of a number of smaller mines, which were generally idle during the year. At least one company, which was in a position to meet the market, preferred not to exhaust reserves. Two of the largest mines, controlled by strong parties, have not made any effort to increase product. In the Bisbee district the Copper Queen consolidated with the Atlanta mine, and was running steadily during the year to the extent of the capacity of its reduction plant. The Copper Prince, a property adjoining the Copper Queen, produced some copper and shipped some ore. In the Clifton district the Detroit and Arizona Companies have both worked steadily, producing a slightly increased quantity of copper. The former company is putting up concentrating works. In Globe the Old Dominion Company ceased operations for a part of the time, and ultimately passed into other hands. It is still hampered by its great distance from railroad transportation. Few details are available concerning the financial results of operations at the Arizona mines. It may be stated, however, in a general way, that costs have been reduced by lowering of price of fuel, cheaper supplies, and reductions in railroad freights, so that those concerns which have a fair and steady supply of good ore are able to meet the market and receive good returns on moderate investments. No large deposits have been developed in new mines during the year, and with the leading concerns following a conservative course, and other producers threatened with possible exhaustion of ore bodies, the tendency in 1886 will be toward a reduction rather than a growth in the output compared with 1885, providing prices do not rise above the level of the early months of the year.

*Montana.*—The principal increase in the production of copper in the United States during 1885 was due to the heavy growth in the output of Montana. The equipment of the leading mines, which was provided in the course of 1884 and added to in some cases in 1885, came into full play during the greater part of the year, and accumulated ore piles in at least one conspicuous instance helped to carry the output very close to its maximum capacity. It has been swelled by the treatment of larger

quantities of first-class ores than will probably be available in some of the leading mines for some time to come. Deeper mining has proved, what was generally expected, the opening up of bodies of lower-grade unaltered ores. As yet this is the case only in individual mines, others containing supplies for years to come of richer material. It is this reserve, on the one hand, and the absolute necessity of keeping large plants in constant operation, which will maintain the product at a high figure, and will cause its rapid increase under the stimulus of any marked advances in the price of the metal. Yet the capacity of the Butte district will be more and more measured by the magnitude of its concentrating and reduction plant, starting with a low-grade ore as the basis.

The works of the Anaconda Company, completed towards the close of 1884, ran steadily during 1885, largely on ore accumulated in former years. This accumulation has been worked up, and the product is dependent more closely upon current extraction of ore, which is not so rich, on an average, as that obtained from the upper levels. This has led to the decision to put up a second concentrating plant, a duplicate of the first, which will be completed during the current year.

The Parrott Company, the second largest producer in the district, has increased its facilities. In the spring of 1886 it had a concentrating mill capable of handling 240 tons of ore per day, a number of roasting kilns, twelve large calcining furnaces, six reverberatory matting furnaces, one 80-ton blast furnace, one small cupola, and six Manhès converters.

The Montana Copper Company has followed the conservative course of closing down its works, preferring to develop its mines and leave its reserves intact rather than exhaust them without reaping adequate returns. The company has a 125-ton concentrating mill, roasts in open heaps, has twelve single and two double calcining furnaces, six reverberatory matting furnaces, and a 40-ton blast furnace.

Mr. A. A. Clark's works consist of a 100 ton concentrating plant, two automatic O'Hara calciners, one reverberatory matting furnace to smelt flue dust, &c., one 40-ton blast furnace, and one 80-ton blast furnace. The latter has been recently completed, but is to be remodeled.

The Orford Sulphur and Copper Company, one of the leading refiners of the Atlantic seaboard, is identified with a plant which includes the 40-ton concentrating mill of the Liquidator Mining Company, leased for one year, one large calcining furnace, one 30-ton and a recently built 125-ton blast furnace.

The smelting works of the Bell Company, which have been idle for some time, consist of two calcining furnaces and two blast furnaces.

The Boston and Montana Company, which works chiefly highly argentiferous copper ores, has a 60-ton concentrating mill, four large calciners, and six matting furnaces. The Anaconda Company has also entered into this business, buying custom ores and smelting them in a blast furnace.

The equipment of the Butte mines has therefore enlarged considerably, but it may be questioned whether, taking into account enforced or voluntary idleness of two works, and the lower grade of the ores of others, especially with low prices for copper, a considerable decline in the production can be prevented.

In the other States and Territories the output of copper has been small. One or two new enterprises have fallen far short of the sanguine expectations of their projectors, and with prices for copper ranging between 10 and 11 cents for lake there is little or no hope for new concerns. Practically, therefore, with prices for lake as low as 10 cents, the contest lies between the producers of the three great districts of the country, each of them favored in some respects and handicapped in others.

## IMPORTS.

The imports of fine copper contained in ores, and regulus and black copper, and of ingot copper, old copper, plates not rolled, rolled plates, sheathing metal, and manufactures not otherwise specified, and of brass, are given in the following tables:

*Fine copper contained in ores, and regulus and black copper imported and entered for consumption in the United States, 1867 to 1885 inclusive.*

| Fiscal years ending June 30— | Fine copper contained in ores. | | Regulus and black copper. (a) | | Total. value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | |
| 1867 | ..... | $936, 271 | ..... | ..... | $936, 271 |
| 1868 | 3, 496, 994 | 197, 203 | ..... | ..... | 197, 203 |
| 1869 | 24, 960, 604 | 448, 487 | ..... | ..... | 448, 487 |
| 1870 | 1, 936, 875 | 134, 736 | ..... | ..... | 134, 736 |
| 1871 | 411, 315 | 42, 453 | 499 | $60 | 42, 513 |
| 1872 | 584, 878 | 69, 017 | 4, 247 | 1, 083 | 70, 100 |
| 1873 | 702, 086 | 80, 132 | 1, 444, 239 | 279, 631 | 359, 763 |
| 1874 | 606, 266 | 70, 633 | 28, 880 | 5, 397 | 76, 030 |
| 1875 | 1, 337, 104 | 161, 903 | 12, 518 | 2, 076 | 163, 979 |
| 1876 | 538, 972 | 68, 922 | 8, 584 | 1, 613 | 70, 535 |
| 1877 | 76, 637 | 9, 756 | 1, 874 | 260 | 10, 016 |
| 1878 | 87, 039 | 11, 785 | ..... | ..... | 11, 785 |
| 1879 | 51, 959 | 6, 199 | ..... | ..... | 6, 199 |
| 1880 | 1, 165, 283 | 173, 712 | 2, 201, 394 | 337, 163 | 510, 875 |
| 1881 | 1, 077, 217 | 124, 477 | 402, 640 | 51, 633 | 176, 110 |
| 1882 | 1, 473, 109 | 147, 416 | 224, 052 | 30, 013 | 177, 429 |
| 1883 | 1, 115, 386 | 113, 349 | ..... | ..... | 113, 349 |
| 1884 | 2, 204, 070 | 219, 957 | 2, 036 | 204 | 220, 161 |
| 1885 | 3, 665, 739 | 343, 793 | 285, 322 | 20, 807 | 304, 600 |

*a* Not enumerated till 1871.

*Copper imported and entered for consumption in the United States,* 1867 *to* 1885 *inclusive.*

| Fiscal years ending June 30— | Bars, ingots, and pigs. | | Old, fit only for remanufacture. | | Old, taken from bottoms of American ships abroad. (*a*) | | Plates not rolled. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | *Pounds.* | |
| 1867 | 1,635,953 | $287,831 | 569,732 | $81,930 | | | | |
| 1868 | 61,394 | 6,935 | 318,705 | 42,652 | | | | |
| 1869 | 13,212 | 2,143 | 290,780 | 34,820 | | | | |
| 1870 | 5,157 | 418 | 255,386 | 31,931 | | | | |
| 1871 | 3,316 | 491 | 369,634 | 45,672 | | | 430 | $129 |
| 1872 | 2,638,589 | 578,965 | 1,144,142 | 178,536 | | | 148,192 | 33,770 |
| 1873 | 9,697,608 | 1,984,122 | 1,413,040 | 255,711 | 32,307 | $4,913 | 550,431 | 97,888 |
| 1874 | 713,935 | 134,326 | 733,326 | 137,087 | 9,500 | 930 | | |
| 1875 | 58,475 | 10,741 | 396,320 | 55,564 | 11,636 | 1,124 | 8 | 4 |
| 1876 | 5,281 | 788 | 239,987 | 35,545 | 10,304 | 1,981 | 5,467 | 600 |
| 1877 | 230 | 30 | 219,443 | 28,608 | 41,482 | 5,136 | | |
| 1878 | 1 | | 198,749 | 25,585 | | 6,004 | | |
| 1879 | 2,515 | 352 | 112,642 | 11,997 | 11,000 | 1,107 | 27,074 | 4,496 |
| 1880 | 1,242,103 | 206,121 | 695,255 | 91,234 | | | 120 | 11 |
| 1881 | 219,802 | 36,168 | 541,074 | 63,383 | 14,680 | 1,504 | 20 | 3 |
| 1882 | 6,200 | 836 | 508,901 | 59,629 | 16,075 | 1,629 | | |
| 1883 | | | 330,495 | 36,166 | 9,415 | 666 | | |
| 1884 | (*b*) 542 | 107 | 149,701 | 12,099 | | 554 | | |
| 1885 | 914 | 172 | 81,312 | 6,658 | | 1,160 | | |

*a* Not enumerated until 1873. *b* Includes "Plates not rolled."

*Copper imported and entered for consumption in the United States, &c.*—Continued.

| Fiscal years ending June 30— | Plates rolled; sheets, pipes, &c. | | Sheathing metal, in part copper. (*a*) | | Manufactures not otherwise specified. | Total value. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Value. | |
| | *Pounds.* | | *Pounds.* | | | |
| 1867 | | $1,101 | 220,889 | $37,717 | $15,986 | $424,565 |
| 1868 | | 1 | 101,488 | 18,852 | 21,492 | 89,932 |
| 1869 | | 39 | 43,669 | 6,592 | 43,212 | 86,800 |
| 1870 | | 2,039 | | | 485,220 | 519,608 |
| 1871 | | 7,487 | | | 668,894 | 722,673 |
| 1872 | | 18,895 | | | 1,007,744 | 1,817,910 |
| 1873 | | 4,514 | | | 869,281 | 3,216,429 |
| 1874 | | 27 | 282,406 | 50,174 | 125,708 | 448,252 |
| 1875 | | 617 | 136,055 | 23,650 | 35,572 | 127,272 |
| 1876 | | 326 | 18,014 | 2,903 | 29,806 | 71,949 |
| 1877 | | 203 | 110 | 22 | 41,762 | 75,761 |
| 1878 | | 1,201 | 647 | 55 | 35,473 | 68,318 |
| 1879 | | 786 | 300 | 20 | 39,277 | 58,035 |
| 1880 | | 4,134 | 6,044 | 693 | 130,329 | 432,522 |
| 1881 | | 82 | 39,520 | 4,669 | 284,509 | 390,318 |
| 1882 | 5,855 | 1,551 | | | 77,727 | 141,372 |
| 1883 | 2,842 | 379 | 6,791 | 1,047 | 40,343 | 78,601 |
| 1884 | 6,529 | 2,330 | 19,637 | 926 | 55,274 | 71,290 |
| 1885 | 470 | 120 | 86,619 | 9,894 | 61,023 | 79,027 |

*a* Does not include copper sheathing in 1867, 1868, and 1869.

*Brass imported and entered for consumption in the United States, 1867 to 1885 inclusive.*

| Fiscal years ending June 30— | Bars and pigs. | | Old, fit only for remanufacture. | | Not otherwise provided for. | Total value. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Value. | |
| | *Pounds.* | | *Pounds.* | | | |
| 1867 | .... | $3,099 | ..... | $26,468 | $170,873 | $200,440 |
| 1868 | 31,104 | 2,071 | 1[illegible]9,913 | 11,699 | 181,114 | 194,883 |
| 1869 | 38,179 | 2,457 | 131,640 | 10,838 | 198,310 | 211,605 |
| 1870 | 54,108 | 3,791 | 98,825 | 6,918 | 49,845 | 60,554 |
| 1871 | 28,453 | 2,803 | 438,085 | 37,922 | 13,659 | 54,384 |
| 1872 | 17,963 | 1,664 | 829,964 | 73,098 | 23,738 | 98,500 |
| 1873 | 56,656 | 7,147 | 699,478 | 71,494 | 114,767 | 193,408 |
| 1874 | 253 | 19 | 682,151 | 64,848 | 350,266 | 415,133 |
| 1875 | 370,273 | 38,867 | 124,285 | 12,786 | 273,873 | 325,526 |
| 1876 | ..... | ..... | 618,191 | 54,771 | 232,870 | 287,641 |
| 1877 | ..... | ..... | 689,633 | 59,402 | 207,642 | 267,044 |
| 1878 | ..... | ..... | 713,171 | 57,551 | 205,209 | 262,760 |
| 1879 | 950 | 49 | 485,354 | 32,278 | 232,030 | 264,357 |
| 1880 | ..... | ..... | 958,590 | 75,093 | 339,131 | 414,224 |
| 1881 | 85,370 | 11,202 | 1,615,402 | 151,541 | 331,506 | 494,249 |
| 1882 | 30,769 | 3,168 | 2,954,148 | 263,891 | 400,477 | 668,136 |
| 1883 | 6,380 | 559 | 1,015,345 | 84,786 | 485,321 | 570,666 |
| 1884 | 1,611 | 445 | 508,923 | 40,766 | 429,224 | 470,435 |
| 1885 | 2,305 | 532 | 166,317 | 15,717 | 400,175 | 416,424 |

## EXPORTS.

The wide fluctuations in the quantities of copper, copper ore, and manufactured copper exported for a series of years are exhibited in the following tables:

*Value of copper, brass, and manufactured copper exported from the United States, 1791 to 1863, inclusive.*

| Fiscal years ending September 30 until 1842, and June 30 since. | Value. | Fiscal years ending September 30 until 1842, and June 30 since. | Value. |
|---|---|---|---|
| 1791 | $493 | 1833 | $203,880 |
| 1803 | 6,233 | 1834 | 198,273 |
| 1804 | 8,654 | 1835 | 69,791 |
| 1805 | 12,977 | 1836 | 72,991 |
| 1806 | 25,340 | 1837 | 91,724 |
| 1807 | 12,742 | 1838 | 81,363 |
| 1808 | 4,031 | 1839 | 81,334 |
| 1809 | 3,095 | 1840 | 86,954 |
| 1810 | 17,426 | 1841 | 72,932 |
| 1811 | 9,282 | 1842 | 97,021 |
| 1812 | 2,644 | 1843 (nine months) | 79,234 |
| 1813 | ..... | 1844 | 91,446 |
| 1814 | ..... | 1845 | 94,736 |
| 1815 | 366 | 1846 | 62,088 |
| 1816 | 16,152 | 1847 | 64,980 |
| 1817 | 8,765 | 1848 | 61,468 |
| 1818 | 33,379 | 1849 | 66,203 |
| 1819 | 12,721 | 1850 | 105,060 |
| 1820 | 18,547 | 1851 | 91,871 |
| 1821 | 26,694 | 1852 | 103,039 |
| 1822 | 36,974 | 1853 | 108,205 |
| 1823 | 16,768 | 1854 | 91,984 |
| 1824 | 26,981 | 1855 | 690,766 |
| 1825 | 30,472 | 1856 | 534,846 |
| 1826 | 60,083 | 1857 | 607,054 |
| 1827 | 52,341 | 1858 | 1,985,223 |
| 1828 | 60,452 | 1859 | 1,048,246 |
| 1829 | 123,647 | 1860 | 1,664,122 |
| 1830 | 36,601 | 1861 | 2,375,029 |
| 1831 | 55,755 | 1862 | 1,098,546 |
| 1832 | 105,774 | 1863 | 1,026,038 |

*Copper and copper ore of domestic production exported from the United States, 1864 to 1885 inclusive.*

[Cwts. are long hundredweights of 112 pounds.]

| Fiscal years ending June 30— | Ore. | | Pigs, bars, sheets, and old. | | Value of manufactured. | Total value. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | | |
| | *Cwts.* | | *Pounds.* | | | |
| 1864 | 109,581 | $181,298 | 102,831 | $43,229 | $208,043 | $432,570 |
| 1865 | 225,197 | 553,124 | 1,572,382 | 709,106 | 282,640 | 1,544,870 |
| 1866 | 215,080 | 792,450 | 123,444 | 33,553 | 110,208 | 936,211 |
| 1867 | 87,731 | 317,791 | (*a*)4,637,867 | 303,048 | 171,062 | 791,901 |
| 1868 | 92,612 | 442,921 | 1,350,896 | 327,287 | 152,201 | 922,409 |
| 1869 | 121,418 | 237,424 | 1,134,360 | 233,932 | 121,342 | 592,698 |
| 1870 | (*a*) 19,198 | 537,505 | 2,214,658 | 385,815 | 118,926 | 1,042,246 |
| 1871 | (*a*) 54,445 | 727,213 | 581,650 | 133,020 | 55,198 | 915,431 |
| 1872 | 35,564 | 101,752 | 267,868 | 64,844 | 121,139 | 287,735 |
| 1873 | 45,252 | 170,365 | 38,958 | 10,423 | 78,288 | 259,076 |
| 1874 | 13,326 | 110,450 | 503,160 | 123,457 | 233,301 | 467,208 |
| 1875 | (*a*) 51,305 | 729,578 | 5,123,470 | 1,042,536 | 43,152 | 1,815,266 |
| 1876 | 15,304 | 84,471 | 14,304,160 | 3,098,395 | 343,544 | 3,526,410 |
| 1877 | 21,432 | 109,451 | 13,461,553 | 2,718,213 | 195,730 | 3,023,394 |
| 1878 | 32,947 | 169,020 | 11,297,876 | 2,102,455 | 217,446 | 2,488,921 |
| 1879 | 23,070 | 102,152 | 17,200,739 | 2,751,153 | 79,900 | 2,933,205 |
| 1880 | 21,623 | 55,763 | 4,206,258 | 667,242 | 126,213 | 849,218 |
| 1881 | 9,958 | 51,499 | 4,865,407 | 786,860 | 38,036 | 876,395 |
| 1882 | 25,936 | 89,515 | 3,340,531 | 565,295 | 93,646 | 748,456 |
| 1883 | 112,923 | 943,771 | 8,221,363 | 1,293,947 | 110,286 | 2,348,004 |
| 1884 | 386,140 | 2,930,895 | 17,044,760 | 2,527,829 | 137,135 | 5,595,859 |
| 1885 | 432,300 | 4,739,601 | 44,731,858 | 5,339,887 | 107,536 | 10,187,024 |

*a* Evidently errors in quantities.

*Value of brass, and manufactures of, exported from the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1867 | $12,864 | 1877 | $327,817 |
| 1868 | 16,841 | 1878 | 589,451 |
| 1869 | 40,063 | 1879 | 200,871 |
| 1870 | 169,997 | 1880 | 183,468 |
| 1871 | 210,816 | 1881 | 216,057 |
| 1872 | 229,458 | 1882 | 322,439 |
| 1873 | 494,575 | 1883 | 287,847 |
| 1874 | 503,531 | 1884 | 301,014 |
| 1875 | 1,000,629 | 1885 | 538,118 |
| 1876 | 256,974 | | |

The problem of tracing the origin of the copper exported is a complicated one, and only a rough distribution of it can be arrived at. The factors which tend to render accuracy impossible are numerous. Copper produced in one section goes to other works for treatment, is refined in another locality, so that its identity is entirely lost. For instance, some copper matte made in Montana goes with material from other sources to the Argo works of the Boston and Colorado Smelting Company, and after extracting the precious metals a part of it is sent abroad direct, another part is refined in the East and is sold to consumers. The refiners themselves, receiving furnace material from many quarters, ship ingot to European markets, and they probably could not, if they

desired it, ascertain whether it was Montana or Arizona produce. Then there appear under exports the quantities of copper extracted from foreign ores and pyrites, either in the form of ingot or of matte. The figures for exports do not, furthermore, exactly tally with the shipments from some localities like Montana, because varying quantities are in transit from the Rocky mountains to the Atlantic and Pacific coasts. While, therefore, strict accuracy is not attainable, an estimate of the sources from which our contribution to foreign markets is made up is not without its great value, because export shipments imply a sacrifice. To the different producing sections it is a matter of moment to obtain some clear conception to what extent its product is placed on the more valuable home market. Past years witnessed a sharp struggle between the Arizona and Lake Superior mines, and in the earlier days of the history of the former region an important percentage out of the whole annual make had to be placed abroad. This seems to have undergone a change worthy of notice.

Out of the entire Arizona product of 22,706,366 pounds fine, not less than 20,300,000 pounds went to American refining works. Out of the balance of 2,400,000 pounds a considerable proportion went direct to consumers in the form of blister copper, they refining it in furnaces, with which a number of them are equipped, or using it direct without refining. This business has grown considerably, so that the quantity of bars, the direct product of Arizona furnaces, exported was probably not more than 1,000,000 pounds. It will be noted, therefore, that only a small percentage of the copper produced in Arizona seeks foreign markets, the bulk of it being consumed at home. This is largely due to the fact that some of the most prominent producing mines are controlled by a concern which does its own refining, and which, as a large manufacturer, consumes the bulk of it.

The scarcity of furnace material from other quarters in the open market has caused our refining works to devote more attention than formerly to the treatment of Montana concentrates and mattes. Our returns from refiners indicate that the total product from that quarter treated by them amounted to no less than 19,000,000 to 20,000,000 pounds. Some of this, converted into electrolytic copper, was undoubtedly exported as such. Other quantities, which cannot be identified as Montana produce, were probably shipped abroad by refiners or second hands, so that ore, concentrates, and matte are not the only forms in which Montana copper went out. Besides it is unnecessary to state that some Manhès' blister produced by the Parrot company was also exported. Taking all these points into consideration, it will be conceded that no small quantity of Montana copper was consumed at home, contrary to the opinion generally prevailing. There was in this movement, which seemed likely to gain rather than to lose strength, a menace to the Lake mines.

The establishment of refining works for handling Montana copper at Bridgeport, and the building of a plant at Belleville, Illinois, near Saint Louis, to employ the processes adopted at the Vivian works, Swansea, point in this direction. This did bring into and will in the near future put upon the market the disturbing element of new brands and new grades of copper, which can only secure recognition by constant concessions. It is claimed that the copper produced from Montana Manhès' blister is as pure as that from Arizona ores, and it is asserted that it approaches Lake copper in quality. These are points which still remain to be proved, but it is undoubtedly suitable for a variety of purposes, like ordinary brass castings, and must displace a corresponding quantity of the better grades. We have no data for estimating the consumption of inferior qualities of the metal. It is undoubtedly large, and it is a problem which once more comes up for solution, to what extent these grades will be allowed to encroach upon markets hitherto controlled by Lake copper. The question is somewhat affected by the relative position of electrolytic copper, some of the Australian brands and Lake metal in the European markets. It is stated with some show of authority that carelessness in treating arsenical material, notably in England, has resulted in a depreciation in quality of electrolytic brands. This has shaken confidence in their quality, and would tend to restore to Lake the advantage of a large extra price, which it had partly lost. This in turn would lessen the anxiety of Lake producers to conquer as great a share of the home market as possible. The sale by the latter of a large block to consumers, at 10 cents, which took place towards the end of May, 1886, showed that they were keenly alive to the dangers of such a competition, and were determined to meet it.

In the form of ingots, bars, and old copper, the exports during the calendar year were 36,221,931 pounds. To this quantity the Lake mines contributed, directly and indirectly, about 24,000,000 to 25,000,000 pounds. Refiners exported 7,145,000 pounds from miscellaneous sources and the balance must be credited to Arizona bars, Montana blister and electrolytic copper, precipitate and Colorado coarse copper. The "ore," which includes concentrates and matte, is estimated to have contained 50,000,000 pounds. The bulk of it is, of course, Montana produce; some of it is, however, matte obtained from smelting the cinder of imported pyrites, used in the manufacture of sulphuric acid. The quantity of copper contained in this "ore" has been arrived at by deducting from the product of the Montana mines the quantities which went to home refiners. It has been claimed, without any further authority than a rough guess, that the quantity thus reached is excessive, and the quantities of "ore" exported in the calendar years 1884 and 1885, with accompanying valuations, have been quoted to give color to this assertion.

*Consumption.*—So much has been said concerning the growth of the copper consumption in this country, stimulated by low prices, that an

effort was made to get at some clear numerical expression which might serve as a guide to the trade. Mr. George W. Cope, of Philadelphia, secretary of the American Iron and Steel Association, a skilled statistician, kindly consented to receive the confidential returns of consumers, and in reply to inquiries the following companies and firms, among whom, it will be noted, are all but two or three of the great manufacturers of brass and copper in the United States, sent the figures covering their consumption of copper bars, ingots, cakes, and slabs:

Coe Brass Manufacturing Company, Torrington, Connecticut.
Waterbury Manufacturing Company, Waterbury, Connecticut.
C. G. Hussey & Co., Pittsburgh, Pennsylvania.
Manhattan Brass Company, New York.
New Haven Copper Company, Seymour, Connecticut.
Bristol Brass and Clock Company, Bristol, Connecticut.
Plume & Atwood Manufacturing Company, Waterbury, Connecticut.
Holmes & Wessel Metal Company, New York.
Bridgeport Brass Company, Bridgeport, Connecticut.
Wallace & Sons, Ansonia, Connecticut.
Waterbury Brass Company, Waterbury, Connecticut.
Shelton Brass Hardware Company, Birmingham, Connecticut.
United Brass Company, Lorain, Ohio.
Haydenville Manufacturing Company, Haydenville, Massachusetts.
Detroit Brass and Copper Company, Detroit, Michigan.
Baltimore Copper Rolling Mill Company, Baltimore, Maryland.
Benedict & Burnham Manufacturing Company, Waterbury, Connecticut.
Ansonia Brass and Copper Company, Ansonia, Connecticut.
Stanier & Laffy, New York.
John A. Roebling's Sons Company, Trenton, New Jersey.
Holmes, Booth & Haydens, Waterbury, Connecticut.
Scovill Manufacturing Company, Waterbury, Connecticut.
Seymour Manufacturing Company, Seymour, Connecticut.
E. Miller & Co., Meriden, Connecticut.
Cheshire Brass Manufacturing Company, Cheshire, Connecticut.
Osborne & Cheeseman Company, Birmingham, Connecticut.
Taunton Copper Manufacturing Company, Taunton, Massachusetts.
De Witt Wire Cloth Company, New York.
Rome Iron Works, Rome, New York.
New Bedford Copper Company, New Bedford, Massachusetts.
James G. Moffatt, New York.
Revere Copper Company, Boston, Massachusetts.

In the aggregate these works consumed 50,011,471 pounds of copper in 1885, against 43,151,960 pounds in 1884, thus indicating a rate of increase of 16 per cent. These figures, it should be distinctly stated, cover only a part of the consumption. They ignore entirely the large quan-

tity annually distributed by dealers, but they do furnish tangible evidence of the growth in the consumption, which is all the more encouraging in times of general business depression, when the consumption of such leading articles as iron and steel remained practically stationary.

One as yet insuperable barrier to any reliable estimates concerning the total copper consumption in this country is the absence of data on stocks. It is possible, therefore, to ascertain only with a fair degree of accuracy how much of the copper product of the country has remained here and how much has gone abroad. Another difficulty is encountered through the fact that the returns of the Bureau of Statistics do not give the copper contents of the "ore," including concentrates and matte exported. This has been overcome largely through special returns from the refiners giving the source of the copper handled by them. From the data obtained the following estimate has been made:

*Estimate of copper consumption in the United States in the calendar year* 1885.

| | *Pounds.* |
|---|---|
| Production, 1885, and excess of imports of fine copper in ore | 170,962,607 |
| Imports of pig and old | 574,514 |
| Total supply | 171,537,121 |
| Exports, ingots and bars | 36,221,931 |
| Exports, copper contents of "ore" | 50,050,000 |
| Re-exports of foreign ore | 348,020 |
| Total exports | 86,619,951 |
| RECAPITULATION. | |
| Production and imports | 171,537,121 |
| Exports | 86,619,951 |
| Available for home consumption | 84,917,170 |

In the report for 1884, published in the "Mineral Resources of the United States," the consumption was estimated at 80,000,000 pounds. In the light of the data received from consumers, it is fair to assume that if the figure for 1884 was correct, that for 1885 must have reached at least 90,000,000 pounds, and that, therefore, there must have been a drain on stocks during the year 1885.

### THE COPPER MARKETS.

The following table summarizes the highest and lowest prices obtained for Lake copper monthly in the New York market from 1860 to 1885, both inclusive:

*Highest and lowest prices of Lake Superior ingot copper, by months, from 1860 to 1885.*

[Cents per pound.]

| Years. | January. | | February. | | March. | | April. | | May. | | June. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1860 | 24 | 23⅜ | 24 | 23⅜ | 23⅜ | 23 | 23⅜ | 23 | 23¼ | 22½ | 22½ | 21¾ |
| 1861 | 20 | 19 | 19½ | 19 | 19¾ | 19¼ | 19¾ | 19 | 19¾ | 19½ | 19 | 18 |
| 1862 | 28 | 27 | 28 | 25 | 25 | 23 | 23 | 21½ | 21½ | 20⅜ | 23 | 20¾ |
| 1863 | 35 | 31 | 37 | 35 | 37 | 31 | 31 | 30 | 30½ | 30 | 30½ | 30 |
| 1864 | 41¼ | 39 | 42 | 41¼ | 42⅜ | 41⅓ | 44 | 42½ | 44 | 43 | 49 | 44 |
| 1865 | 50⅜ | 46 | 46 | 44 | 44⅓ | 34 | 35 | 34 | 34 | 30 | 30½ | 28⅓ |
| 1866 | 42 | 38 | 38 | 35½ | 35½ | 29⅓ | 30 | 28⅓ | 31 | 29 | 33 | 31 |
| 1867 | 29¼ | 27 | 27¾ | 27½ | 27½ | 24 | 24½ | 23½ | 24½ | 24 | 24½ | 24 |
| 1868 | 23½ | 21½ | 24 | 22½ | 24 | 23¼ | 24¼ | 23¼ | 24½ | 24 | 24 | 23⅓ |
| 1869 | 26¼ | 23¾ | 27 | 26 | 26⅜ | 24 | 24 | 23¼ | 24¼ | 23⅜ | 23¾ | 22 |
| 1870 | 22 | 21⅜ | 21¼ | 20⅞ | 20¾ | 19 | 19¾ | 19¼ | 19⅜ | 19 | 20⅜ | 19 |
| 1871 | 22⅞ | 22 | 22⅜ | 21⅞ | 22 | 21⅓ | 21¾ | 21¼ | 21¾ | 21⅜ | 21⅛ | 21¼ |
| 1872 | 28½ | 27⅜ | 28⅜ | 28¼ | 30½ | 28⅜ | 44 | 30½ | 42 | 36 | 34¾ | 33 |
| 1873 | 35 | 32½ | 35 | 34 | 35 | 34½ | 34½ | 33½ | 33½ | 32 | 31½ | 29⅜ |
| 1874 | 25 | 24½ | 25 | 24½ | 24¾ | 24 | 25 | 24¾ | 25 | 24½ | 24¾ | 24¼ |
| 1875 | 23½ | 21½ | 22¾ | 21¾ | 21¾ | 21½ | 21¾ | 21½ | 23¼ | 22⅜ | 23 | 23 |
| 1876 | 23¼ | 23 | 22⅜ | 22⅓ | 22¼ | 22 | 22⅜ | 22 | 22⅜ | 21 | 21 | 19¼ |
| 1877 | 19⅓ | 19 | 20⅓ | 19⅓ | 19⅜ | 19 | 19⅜ | 19¼ | 19¼ | 19 | 19⅜ | 19 |
| 1878 | 17⅜ | 17¼ | 17½ | 17⅛ | 17⅜ | 16⅞ | 17 | 16⅞ | 16¼ | 16½ | 16⅜ | 16¼ |
| 1879 | 16 | 15⅛ | 15⅛ | 15½ | 15¾ | 15¼ | 16 | 15⅜ | 16¼ | 16 | 16¼ | 16⅛ |
| 1880 | 25 | 21⅜ | 24½ | 24 | 24 | 22¾ | 22½ | 21 | 21 | 18 | 18⅜ | 17⅞ |
| 1881 | 19⅜ | 19⅛ | 19⅜ | 19⅛ | 19⅜ | 19 | 19 | 18¾ | 18⅞ | 18½ | 18¼ | 16⅜ |
| 1882 | 20⅜ | 20¼ | 20 | 19 | 19½ | 18⅞ | 18⅞ | 17⅞ | 18¼ | 18 | 18¼ | 18 |
| 1883 | 18⅜ | 18 | 17⅞ | 17¾ | 17⅜ | 17⅛ | 16 | 15¾ | 16 | 15⅞ | 15⅛ | 15 |
| 1884 | 15 | 14⅞ | 15 | 14⅝ | 15 | 14⅞ | 15 | 14⅜ | 14¼ | 14⅛ | 14¼ | 14 |
| 1885 | 11½ | 10⅝ | 11⅜ | 10⅛ | 11⅛ | 10⅝ | 11¼ | 10.10 | 11⅛ | 9⅜ | 11⅓ | 11 |

| Years. | July. | | August. | | September. | | October. | | November. | | December. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1860 | 21¾ | 21½ | 21½ | 21½ | 22 | 21¼ | 22 | 21½ | 21⅛ | 20¼ | 20¼ | 19¾ |
| 1861 | 18 | 17½ | 19 | 17¾ | 20¼ | 19 | 20¼ | 20 | 23½ | 20¼ | 27 | 22½ |
| 1862 | 24½ | 22½ | 24½ | 24 | 27 | 24¼ | 32⅞ | 27 | 32⅞ | 30⅛ | 31⅛ | 30½ |
| 1863 | 32 | 29 | 31 | 29 | 32½ | 31 | 34½ | 32¼ | 38⅜ | 34⅓ | 38⅝ | 38½ |
| 1864 | 55 | 49 | 52½ | 50 | 52¾ | 47⅓ | 48 | 47 | 49 | 47 | 50 | 48½ |
| 1865 | 30¼ | 28 | 32 | 30½ | 32¾ | 31⅛ | 33 | 32½ | 45½ | 33 | 45½ | 39¼ |
| 1866 | 33⅜ | 31 | 31 | 30 | 31⅜ | 30⅜ | 31 | 30¾ | 30¾ | 26⅓ | 29 | 26½ |
| 1867 | 26 | 24 | 26½ | 25¾ | 27¼ | 26½ | 26⅜ | 22¾ | 23 | 22⅜ | 23 | 21⅛ |
| 1868 | 24⅓ | 23⅛ | 24¼ | 24 | 24 | 23¾ | 24 | 23 | 24 | 22½ | 24¼ | 23¾ |
| 1869 | 22¼ | 21⅞ | 23⅛ | 21⅞ | 23 | 22 | 22¾ | 2[illegible] | 22½ | 22 | 22 | 21⅛ |
| 1870 | 20⅛ | 20⅜ | 21⅜ | 20¼ | 21½ | 20⅜ | 21⅜ | 21½ | 23⅜ | 21¾ | 22⅝ | 22¼ |
| 1871 | 22¼ | 21⅝ | 23 | 22⅜ | 23⅞ | 22⅞ | 23⅞ | 23¼ | 24¼ | 23¼ | 27 | 24½ |
| 1872 | 34 | 33 | 35 | 32½ | 35¼ | 33 | 34¼ | 31¼ | 32¼ | 30⅜ | 32½ | 30½ |
| 1873 | 29 | 26⅜ | 27⅓ | 27 | 27 | 25½ | 25½ | 24 | 24 | 21 | 25 | 23 |
| 1874 | 24½ | 20 | 21 | 19 | 21½ | 21 | 22¼ | 21½ | 23⅜ | 22¼ | 23¼ | 23¼ |
| 1875 | 23 | 22⅝ | 23⅜ | 23 | 23⅞ | 23⅜ | 23¼ | 23 | 23¼ | 23 | 23⅜ | 23⅜ |
| 1876 | 20 | 19½ | 19⅛ | 18¾ | 21 | 18¾ | 21¼ | 20½ | 20½ | 20 | 20 | 19⅝ |
| 1877 | 19½ | 19 | 19 | 17⅞ | 18½ | 17⅝ | 18 | 17¾ | 17⅜ | 17⅜ | 17¾ | 17½ |
| 1878 | 16¼ | 16 | 16 | 16 | 16¼ | 16 | 16 | 15⅜ | 15⅞ | 15⅜ | 16 | 15⅞ |
| 1879 | 16⅛ | 16 | 16⅜ | 16 | 17 | 16¼ | 21½ | 18 | 21⅛ | 21 | 21½ | 21 |
| 1880 | 18⅞ | 18½ | 19⅛ | 19 | 18⅞ | 18¾ | 18⅞ | 18¾ | 18⅞ | 18¾ | 19⅛ | 18⅞ |
| 1881 | 16⅛ | 16 | 16⅝ | 16⅜ | 18½ | 16⅜ | 18⅜ | 18 | 19 | 18½ | 20⅜ | 19¼ |
| 1882 | 18¼ | 18½ | 18¼ | 18⅛ | 18¼ | 18 | 18¼ | 18 | 18½ | 18 | 18 | 17⅞ |
| 1883 | 15⅛ | 15 | 15 | 15 | 15¼ | 15⅛ | 15¼ | 15⅛ | 15 | 14⅞ | 15 | 14⅞ |
| 1884 | 14⅛ | 13⅞ | 14 | 13⅞ | 13⅛ | 13 | 13⅛ | 12⅞ | 13 | 12⅜ | 12⅛ | 11 |
| 1885 | 11¼ | 10⅝ | 11¼ | 11 | 11⅛ | 10.95 | 11⅛ | 10⅝ | 11⅛ | 10⅝ | 11½ | 11.10 |

1885. The following shows the fluctuations of Lake copper and ordinary Baltimore, or its equivalent, in the open market:

*Prices of copper in* 1885.

[Cents per pound.]

| Months. | Lake copper. | | Casting copper. | |
|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. |
| January | 11.50 | (a)10.60 | 10.75 | 10.25 |
| February | 11.12½ | (a)10.80 | 10.75 | 10.50 |
| March | 11.12½ | (a)10.40 | 10.62½ | 10.12½ |
| April | 11.25 | (a)10.10 | 10.75 | 10.25 |
| May | 11.50 | (a)9.80 | 10.89½ | 10.60 |
| June | 11.50 | 11.00 | 10.62½ | 10.20 |
| July | 11.25 | 10.87½ | 10.35 | 10.20 |
| August | 11.25 | 11.00 | 10.35 | 10.15 |
| September | 11.12½ | 10.95 | 10.25 | 10.10 |
| October | 11.12½ | 10.80 | 10.12 | 9.90 |
| November | 11.12½ | 10.80 | 10.00 | 9.80 |
| December | 11.50 | 11.10 | 10.50 | 10.00 |

*a* Under Chili bar sliding-scale contracts.

The market opened quiet in January, the transactions in Lake on the open market being few, since the principal consumers were being supplied under the sliding-scale contracts entered into during the preceding year. Under these contracts the prices to consumers are estimated at 10.60 cents for January, 10.80 cents for February, 10.40 cents for March, 10.10 cents for April, and 9.80 cents for May, in accordance with the steady decline in Chili bars abroad. This offered little inducement to consumers to purchase other copper than Lake, and the market remained very quiet until the close of April, when the stock, estimated at 1,000,000 pounds, held by a bankrupt refining company, was closed out. In May consumers again entered into a contract with the leading Lake companies for 10,000,000 pounds at 11½ cents. The market again became dull, and the continuance of the decline abroad to unprecedented figures created a depressed feeling, causing general weakness. Early in September 11 cents was made the basis of Lake contracts with consumers, and, under the pressure of supplies of other Lake, Arizona, and Montana copper, the market receded steadily till the middle of November. The sudden advance at London gave encouragement here, and the spot stocks being small, with a heavy export and a large consumption, the price gradually rallied. The tone became so strong that the Lake companies were enabled to make 11½ cents the basis of the contracts, for 10,000,000 pounds, with consumers, covering the early months of 1886. During the entire year our market has been relatively higher than those abroad, and since the end of the sliding-scale contracts the bulk of the Lake copper has sold at an average considerably above 11 cents.

The prices realized for copper during the year are best indicated by the figures given in a number of the reports of the Lake Superior companies. The following table has been compiled from those documents:

*Prices realized for Lake Superior copper in* 1883 *and* 1885.

| Mines. | 1883. | | 1885. | |
|---|---|---|---|---|
| | Sales. | Average price. | Sales. | Average price. |
| | *Pounds.* | *Cts. per lb.* | *Pounds.* | *Cts. per lb.* |
| Allouez | 1,751,377 | 15.13 | (*b*)1,050,546 | 11.03 |
| Franklin | 3,418,456 | 15.66 | 3,291,806 | 11.04 |
| Atlantic | 2,385,585 | 15.08 | (*a*)2,729,588 | 11.08 |
| Pewabic | 1,239,740 | 15.91 | ..... | ..... |
| Central | 1,125,910 | 15.08 | (*a*)1,600,899 | 11.02 |
| Huron | 647,787 | 15.69 | 2,729,588 | 10.92 |
| Osceola | ..... | ..... | 1,639,169 | 10.75 |

*a* Not including copper on hand sold. *b* First five months.

Since the English quotations have become of such direct importance to American copper miners, the following table, showing a comparison of values in 1885 with former years, is of interest:

*Average values in England.*

| Years. | Chili bars. | Ore, 25 per cent. | Precipitate. |
|---|---|---|---|
| | *Long ton.* | *Per unit.* | *Per unit.* |
| 1880 | £62 10 0 | £0 12 9 | £0 12 11 |
| 1881 | 61 10 0 | 12 6 | 13 $8\frac{3}{16}$ |
| 1882 | 66 17 0 | 13 $6\frac{3}{4}$ | 13 $10\frac{1}{16}$ |
| 1883 | 63 5 10 | 12 $4\frac{1}{3}$ | 12 $10\frac{1}{16}$ |
| 1884 | 54 9 1 | 10 $5\frac{1}{2}$ | 11 1 |
| 1885 | 44 0 10 | 8 4 | 9 $0\frac{1}{8}$ |

In detail the average prices monthly during 1885 were as follows:

*Monthly averages of values in England in* 1885.

| Months. | Chili bars, per long ton. | Ore of 25 per cent., per unit. | Precipitate, per unit. |
|---|---|---|---|
| | £ s. d. | s. d. | s. d. |
| January | 48 14 7 | 9 3 | 9 $11\frac{1}{2}$ |
| February | 47 13 6 | 9 0 | 9 $8\frac{7}{8}$ |
| March | 46 4 9 | 8 7 | 9 $5\frac{1}{2}$ |
| April | 44 9 2 | 7 11 | 9 $1\frac{1}{2}$ |
| May | 44 13 6 | 8 3 | 9 $1\frac{5}{8}$ |
| June | 44 18 3 | 8 3 | 9 $2\frac{1}{2}$ |
| July | 44 4 9 | 8 3 | 9 $0\frac{5}{8}$ |
| August | 43 5 11 | 8 3 | 8 $10\frac{1}{2}$ |
| September | 41 17 6 | 7 11 | 8 7 |
| October | 39 18 6 | 7 9 | 8 $2\frac{3}{8}$ |
| November | 41 3 0 | 8 0 | 8 $5\frac{1}{4}$ |
| December | 41 6 6 | 8 0 | 8 $5\frac{5}{8}$ |

### THE PRINCIPAL FOREIGN PRODUCERS.

As the United States has become one of the heaviest contributors to foreign markets, and the returns received for that share of its produce shipped abroad depend upon the capacity of its competitors to meet prevailing prices, the conditions affecting the mines in all quarters of the

globe have become a matter of keen interest. These influences re-act upon our home markets, though they are tempered by a variety of circumstances. The year 1885 with its low prices has exerted an enormous pressure upon the copper mines in all the different countries. The great pyrites companies of the Spanish peninsula have been forced to reduce dividends heavily, in spite of their efforts to decrease costs by increasing output, and although they were earning well on sales of pyrites. The producers in Chili are, according to the latest authoritative advices, finding it difficult to make ends meet, although exchange has favored them. The Australian and Venezuelan mines have lost money, and the Mansfeld company in Germany is seeking relief by agitating for a higher duty. The magnificent profits of the Cape of Good Hope mine have shrunk to low figures. The smaller concerns, scattered in different countries, have either closed down completely, or are lingering on reserves, so that the contest has narrowed down to a struggle between a few large producers. Although consumption has increased somewhat as the result of low values, their combined output is too great to allow of any material rise so long as the general business situation the world over remains as unfavorable as it has been for some time past, and even moderate supplies are shipped abroad from this country.

Messrs. Henry Merton & Co. have compiled the following table of the copper production of the world, and have since its publication kindly completed some of the estimates when later returns were available. Some of the data have been changed and corrected by this office from information directly received from various quarters. The copper is in all cases credited to the source where it originated. Thus the contents of the pyrites shipped from Spain are included in the figures given for that country. The table as it stands reflects the results of the closest scrutiny and may be accepted as the most complete and accurate now available:

*The copper production of the world, 1879 to 1885 inclusive.*

| Countries. | 1885. | 1884. | 1883. | 1882. | 1881. | 1880. | 1879. |
|---|---|---|---|---|---|---|---|
| EUROPE. | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Great Britain | 2,773 | 3,350 | 2,620 | 3,464 | 3,875 | 3,662 | 3,462 |
| Spain and Portugal: | | | | | | | |
| Rio Tinto | 23,484 | 21,564 | 20,472 | 17,389 | 16,666 | 16,215 | 13,751 |
| Tharsis | (*a*) 11,500 | (*a*) 10,800 | 9,800 | 9,000 | 10,203 | 9,151 | 11,224 |
| Mason & Barry | (*a*) 7,000 | (*a*) 7,500 | 8,000 | 8,000 | 8,170 | 6,603 | 4,692 |
| Sevilla | 1,800 | 2,000 | 2,026 | 1,885 | 1,340 | 1,705 | 1,360 |
| Portugueza | 1,665 | (*a*) 2,300 | 2,357 | 1,700 | 1,410 | 1,000 | 770 |
| Poderosa | (*a*) 500 | (*a*) 500 | 1,000 | 800 | 800 | 800 | 800 |
| Germany: | | | | | | | |
| Mansfeld | 12,450 | 12,582 | 12,634 | 11,536 | 10,999 | 9,800 | 8,400 |
| Other German | (*a*) 2,800 | (*a*) 2,200 | 3,568 | 3,552 | 1,743 | 1,000 | 600 |
| Austria | (*a*) 670 | 670 | 572 | 474 | 474 | 500 | 255 |
| Hungary | (*a*) 800 | 800 | 661 | 661 | 800 | 900 | 1,019 |
| Sweden | 775 | 662 | 732 | 798 | 995 | 1,074 | 800 |
| Norway | 2,560 | 2,706 | 2,630 | 2,590 | 2,640 | 2,426 | 2,412 |
| Italy | 835 | 1,325 | 1,600 | 1,400 | 1,480 | 1,380 | 1,140 |
| Russia | (*a*) 5,000 | 5,000 | 3,500 | 3,537 | 3,411 | 3,154 | 3,081 |
| **Total Europe** | 74,612 | 73,959 | 72,172 | 66,786 | 65,006 | 59,370 | 53,866 |

*a*. Estimated.

*The copper production of the world,* 1879 *to* 1885 *inclusive*—Continued.

| Countries. | 1885. | 1884. | 1883. | 1882. | 1881. | 1880. | 1879. |
|---|---|---|---|---|---|---|---|
| NORTH AMERICA. | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| United States | 74,053 | 62,555 | 51,574 | 40,467 | 32,000 | 27,000 | 23,000 |
| Canada | ..... | 236 | 1,055 | 500 | 500 | 50 | 50 |
| Newfoundland: | | | | | | | |
| Bett's Cove | 778 | 668 | 1,053 | 1,500 | 1,718 | 1,500 | 1,500 |
| Mexico | 375 | 291 | 489 | 401 | 333 | 400 | 400 |
| Total North America | 75,206 | 64,750 | 54,171 | 42,868 | 34,551 | 28,950 | 24,950 |
| SOUTH AMERICA. | | | | | | | |
| Chili | 38,500 | 41,648 | 41,099 | 42,909 | 37,989 | 42,916 | 49,318 |
| Bolivia: | | | | | | | |
| Corocoro | (*a*) 1,500 | (*a*) 1,500 | 1,680 | 3,259 | 2,655 | 2,000 | 2,000 |
| Peru | 229 | 362 | 395 | 440 | 615 | 600 | 600 |
| Venezuela: | | | | | | | |
| New Quebrada | 4,111 | 4,600 | 4,018 | 3,700 | 2,823 | 1,800 | 1,597 |
| Argentine Republic | 233 | 159 | 293 | 800 | 307 | 300 | 300 |
| Total South America | 44,573 | 48,269 | 47,485 | 51,108 | 44,389 | 47,616 | 53,815 |
| AFRICA. | | | | | | | |
| Algiers | 250 | 260 | 600 | 600 | 600 | 500 | 500 |
| Cape of Good Hope: | | | | | | | |
| Cape Copper Company | 5,450 | 5,000 | 5,975 | 5,716 | 3,467 | 4,739 | 4,328 |
| Total Africa | 5,700 | 5,260 | 6,575 | 6,316 | 4,067 | 5,239 | 4,828 |
| ASIA. | | | | | | | |
| Japan | (*a*) 10,000 | (*a*) 10,000 | 7,600 | 4,800 | 3,900 | 3,900 | 3,900 |
| Total Asia | 10,000 | 10,000 | 7,600 | 4,800 | 3,900 | 3,900 | 3,900 |
| AUSTRALIA. | | | | | | | |
| Australia | 11,400 | 14,100 | 12,271 | 8,512 | 10,000 | 9,700 | 9,500 |

*a* Estimated.

RECAPITULATION.

| | 1885. | 1884. | 1883. | 1882. | 1881. | 1880. | 1879. |
|---|---|---|---|---|---|---|---|
| Europe | 74,839 | 73,959 | 72,172 | 66,786 | 65,006 | 59,370 | 53,866 |
| North America | 75,206 | 64,750 | 54,171 | 42,868 | 34,551 | 28,950 | 24,950 |
| South America | 44,573 | 48,269 | 47,485 | 51,108 | 44,389 | 47,616 | 53,815 |
| Africa | 5,700 | 5,260 | 6,575 | 6,316 | 4,067 | 5,239 | 4,828 |
| Asia | 10,000 | 10,000 | 7,600 | 4,800 | 3,900 | 3,900 | 3,900 |
| Australia | 11,400 | 14,100 | 12,271 | 8,512 | 10,000 | 9,700 | 9,500 |
| Total | 221,491 | 216,338 | 200,274 | 180,390 | 161,913 | 154,775 | 150,859 |

*Great Britain.*—The following are the official returns of the quantity of ore and precipitate produced by English mines, and their copper contents, or, as the latest report puts it, "metallic copper obtainable by smelting."

*Production of copper in Great Britain.*

| Years. | Ore. | Copper. | Years. | Ore. | Copper. |
|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | | *Long tons.* | *Long tons.* |
| 1860 | 362,696 | 15,968 | 1877 | 73,143 | 4,486 |
| 1865 | 198,298 | 11,888 | 1878 | 56,094 | 3,952 |
| 1870 | 106,698 | 7,175 | 1879 | 51,035 | 3,462 |
| 1871 | 97,129 | 6,280 | 1880 | 52,118 | 3,662 |
| 1872 | 91,893 | 5,703 | 1881 | 52,556 | 3,875 |
| 1873 | 80,188 | 5,240 | 1882 | 52,810 | 3,464 |
| 1874 | 78,521 | 4,981 | 1883 | 46,820 | 2,620 |
| 1875 | 71,528 | 4,323 | 1884 | 42,149 | 3,350 |
| 1876 | 79,252 | 4,694 | 1885 | 36,379 | 2,773 |

According to the official returns of the Board of Trade the British imports and exports of copper have been as follows for a series of years:

*British imports and exports of copper.*

| Years. | Imports of— | | Total imports. | Exports. |
|---|---|---|---|---|
| | Bars, cakes, and ingots. | Copper in ores and furnace products. | | |
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| 1860 | 13,142 | 13,715 | 26,857 | 26,117 |
| 1865 | 23,137 | 23,922 | 47,059 | 41,398 |
| 1870 | 30,724 | 27,025 | 57,749 | 53,006 |
| 1871 | 33,228 | 23,671 | 56,899 | 56,633 |
| 1872 | 49,000 | 21,702 | 70,702 | 53,195 |
| 1873 | 35,840 | 26,756 | 62,596 | 55,716 |
| 1874 | 39,906 | 27,894 | 67,800 | 59,742 |
| 1875 | 41,931 | 29,483 | 71,414 | 51,870 |
| 1876 | 39,145 | 36,191 | 75,336 | 52,468 |
| 1877 | 39,743 | 53,582 | 93,325 | 54,088 |
| 1878 | 39,360 | 48,212 | 87,572 | 55,001 |
| 1879 | 46,670 | 50,421 | 97,091 | 62,412 |
| 1880 | 36,509 | 56,225 | 92,734 | 59,482 |
| 1881 | 32,170 | 54,057 | 86,227 | 61,689 |
| 1882 | 35,509 | 58,366 | 93,875 | 55,683 |
| 1883 | 35,653 | 63,493 | 99,146 | 59,350 |
| 1884 | 39,767 | 72,617 | 112,384 | 64,692 |
| 1885 | 41,931 | 81,616 | 123,547 | 62,050 |

The following figures from the Board of Trade returns for the eight years since 1878 show in detail the form in which the copper is brought into Great Britain and in what form it is exported:

*Imports of copper into Great Britain from* 1878 *to* 1885 *inclusive.*

| Character. | 1878 | 1879. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Pure in pyrites | 14,443 | 12,040 | 16,446 | 13,551 | 15,672 | 15,016 | 14,077 | 16,333 |
| Pure in precipitate | 13,173 | 18,159 | 18,205 | 18,619 | 17,935 | 23,645 | 19,688 | 21,398 |
| Pure in ore | 15,441 | 13,173 | 14,976 | 15,396 | 15,489 | 15,880 | 24,677 | 15,683 |
| Pure in regulus | 5,155 | 7,049 | 6,598 | 6,491 | 9,270 | 8,952 | 11,181 | 28,202 |
| Bars, cakes, etc. | 39,360 | 46,670 | 36,509 | 32,170 | 35,509 | 35,653 | 39,767 | 41,931 |
| Total | 87,572 | 97,991 | 92,734 | 86,227 | 93,875 | 99,146 | 109,390 | 123,547 |

Turning first to the imports of pyrites, we find the following table of the imports and their source since 1873 in the volume of the "Mineral Statistics of Great Britain":

*Imports of pyrites into Great Britain.*

| Years. | Norway. | Portugal. | Spain. | Germany. | Other countries. | Total. |
|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| 1873 | 67,462 | 199,559 | 246,692 | ..... | 6,634 | 520,347 |
| 1874 | 41,044 | 162,569 | 294,117 | ..... | 907 | 498,637 |
| 1875 | 21,820 | 165,433 | 344,019 | ..... | 6,283 | 537,555 |
| 1876 | 7,688 | 56,579 | 419,068 | ..... | 21,417 | 504,752 |
| 1877 | 8,564 | 149,562 | 498,977 | ..... | 22,209 | 679,312 |
| 1878 | 5,773 | 136,705 | 419,561 | ..... | 12,318 | 474,357 |
| 1879 | 8,485 | 82,529 | 374,505 | ..... | 15,783 | 481,302 |
| 1880 | 10,952 | 166,519 | 463,199 | 8,695 | 8,684 | 658,049 |
| 1881 | 6,009 | 140,079 | 379,216 | 8,412 | 8,662 | 542,378 |
| 1882 | ..... | 114,132 | 497,807 | ..... | 15,761 | 627,700 |
| 1883 | 1,271 | 121,137 | 473,343 | ..... | 5,537 | 601,288 |
| 1884 | 522 | 85,454 | 471,556 | ..... | 5,541 | 563,073 |
| 1885 | 2,608 | 28,899 | 619,523 | ..... | 3,491 | 654,521 |

These figures show clearly how the Spanish mines are rapidly monopolizing the English pyrites trade.

The following table exhibits the quantity of burned pyrites treated at the twenty-two metal-extraction works, together with the quantities of metallic copper and gold and silver extracted by the Claudet process:

*Metals extracted from burned cupriferous pyrites.*

| Years. | Ore. | Copper. | Gold. | Silver. |
|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Ounces.* | *Ounces.* |
| 1880 | 415,567 | 15,000 | 1,043 | 246,981 |
| 1881 | 396,737 | 14,000 | 1,490 | 258,463 |
| 1882 | 434,427 | 15,300 | 1,500 | 400,000 |
| 1883 | 439,156 | 15,370 | 1,511 | 348,210 |
| 1884 | 416,412 | 15,200 | 1,900 | 345,000 |
| 1885 | 407,700 | 14,880 | 1,840 | 328,000 |

The decline in the consumption of sulphuric acid and of soda manufacture has therefore only had a moderate effect, chiefly for the reason that the Solvay ammonia process has thus far made its greatest strides on the Continent.

The following table giving the returns covering the imports of precipitate and regulus, or matte, into Great Britain for the first time enumerates specially the amounts received from this country. The enormously rapid growth deserves special notice. It will be observed also that the imports of Spanish precipitate show a very large increase, eclipsing all former years.

*Imports of precipitate and regulus into Great Britain.*

| Countries. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | Containing fine copper (estimated). |
|---|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Portugal | 5,358 | 8,144 | 7,301 | 8,873 | 7,161 | 8,283 | 25,487 |
| Spain | 20,482 | 21,647 | 21,398 | 28,962 | 27,621 | 38,267 | |
| Chili | 14,659 | 8,116 | 10,882 | 6,384 | 10,699 | 5,255 | 2,365 |
| United States | ..... | ..... | ..... | ..... | 5,805 | 29,861 | 18,895 |
| Other countries | 4,502 | 6,309 | 9,716 | 13,509 | 11,124 | 6,000 | 2,853 |
| Total | 45,001 | 44,216 | 49,297 | 57,728 | 62,410 | 87,666 | 49,600 |
| Pure copper | 24,772 | 25,110 | 27,205 | 32,597 | 34,172 | 49,600 | ..... |

Another great source of supply of the English metallurgical works is ore. The following table gives the Board of Trade returns, the average values being computed by this office.

*Imports of copper ore into Great Britain.*

| Countries. | Quantities. | | | Average value per ton. | | |
|---|---|---|---|---|---|---|
| | 1883. | 1884. | 1885. | 1883. | 1884. | 1885. |
| | *Long tons.* | *Long tons.* | *Long tons.* | | | |
| Italy | 9,403 | 11,100 | 7,405 | £7.11 | £4.79 | £5.42 |
| Venezuela | 31,844 | 25,900 | 38,613 | 6.73 | 6.16 | 4.46 |
| Bolivia | 1,029 | 2,067 | 4,642 | 12.98 | 8.81 | 8.22 |
| Chili | 1,062 | 245 | 529 | 13.17 | 19.92 | 17.10 |
| Cape of Good Hope | 19,917 | 22,330 | 20,875 | 17.71 | 15.35 | 11.80 |
| British North America | 10,876 | 2,067 | 5,002 | 6.04 | 4.35 | 2.02 |
| United States | ..... | 31,316 | 5,970 | ..... | 18.94 | 14.27 |
| Other countries | 31,748 | 29,189 | 18,941 | 11.65 | 6.76 | 6.79 |
| Total ore | 105,879 | 124,214 | 101,977 | 10.35 | 11.09 | 7.07 |
| Total pure copper | 15,880 | 24,842 | 15,683 | ..... | ..... | ..... |
| Average percentage | 15.00 | 20.00 | 14.43 | ..... | ..... | ..... |

These figures are deeply interesting because they show what a complete revulsion was effected in one year in the character of the shipments from this country, which is for the first time taken from the general heading of "other countries." In one year we sent 31,316 long tons of copper ore, in the next only 5,970 tons, and of the latter the bulk were concentrates. This is particularly instructive because our own export statistics group ore and matte together as "ore." This has led to very erroneous deductions, it being assumed that since the quantities sent show little variation, it follows that the copper contents are nearly alike. It is probable that the ore sent in 1884 did not average higher than 30 per cent., while the grade of the matte exported is probably nearer 60 per cent. The English receipts were of both in 1884 and 1885:

| | 1884. | 1885. |
|---|---|---|
| | *Long tons.* | *Long tons.* |
| Ore | 31,316 | 5,970 |
| Matte | 5,805 | 29,861 |
| Total | 37,121 | 35,831 |

This change in the character of our exports is of course largely due to the cessation of ore shipments late in 1884 by the Anaconda mine, and the starting of the smelting plant of that company.

The values per ton computed in the above table show clearly that whenever it was possible the mines of the different countries sorted their ore much more carefully, carrying up its grade. When this was impossible, as in the case of the receipts from British North America, the value per ton declined very heavily.

The chief sources of the receipts of ingot copper and of bars are Australia, furnishing the former, and Chili which sends the latter. A comparatively small quantity is received from the United States, which probably in 1885 included also some Montana blister.

*Imports of copper, wrought and unwrought, into Great Britain.*

| Countries. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Chili | 24,258 | 21,019 | 22,585 | 22,799 | 22,843 | 24,832 |
| Australia | 9,406 | 9,150 | 8,152 | 9,531 | 9,329 | 8,564 |
| United States | ..... | ..... | ..... | 1,866 | 3,408 | 3,259 |
| Other countries | 2,845 | 2,001 | 4,772 | 1,457 | 4,235 | 5,338 |
| Total | 36,509 | 32,170 | 35,509 | 35,653 | 39,815 | 41,993 |

Messrs. James Lewis & Son, of Liverpool, estimate as follows the imports of other than Chili copper into Liverpool, London, and Swansea during the years 1882, 1883, 1884, and 1885, which represents the total imports, with the exception of precipitate, into Newcastle and Cardiff, reliable returns of which cannot be obtained, but which is estimated to vary from 10,000 to 12,000 tons fine per annum.

*Imports of copper produce into Liverpool, Swansea, and London.*

| Countries. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Chili | 30,112 | 27,504 | 31,298 | 28,985 |
| United States | 745 | 9,410 | 17,309 | 24,037 |
| Spain and Portugal | 464 | 2,788 | 2,359 | 4,655 |
| Spain (precipitate) | 8,757 | 11,249 | 10,009 | 9,186 |
| Spain (pyrites) | 15,673 | 15,017 | 14,077 | 16,333 |
| Australia | 9,847 | 9,694 | 9,685 | 8,951 |
| Cape of Good Hope | 5,298 | 5,670 | 6,042 | 5,405 |
| New Quebrada | 3,164 | 3,960 | 3,675 | 4,074 |
| Japan | ..... | ..... | 1,064 | 3,010 |
| Italy | 1,386 | 1,091 | 1,310 | 835 |
| Norway | 446 | 296 | 289 | 27 |
| Canada | 347 | 448 | 266 | ..... |
| Newfoundland | 1,362 | 1,185 | 224 | 723 |
| Mexico | 372 | 489 | 291 | 374 |
| Peru | 821 | 426 | 408 | 229 |
| River Plate | 260 | 319 | 131 | 233 |
| Other countries | 925 | 946 | 284 | 325 |
| Total, tons fine | 79,979 | 90,492 | 98,721 | 107,382 |

The exports of copper from Great Britain, in different forms, were as follows:

*Exports of copper from Great Britain from 1878 to 1885, inclusive.*

| Character. | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Raw English | 17,319 | 16,370 | 15,202 | 18,737 | 12,776 | 16,777 | 17,943 | 18,736 |
| Sheets | 12,769 | 15,402 | 16,580 | 15,960 | 15,698 | 16,071 | 20,669 | 21,108 |
| Yellow metal, at 60 per cent | 8,744 | 10,042 | 10,128 | 9,939 | 10,892 | 11,918 | 11,602 | 12,551 |
| Brass, at 70 per cent | 3,450 | 2,761 | 2,677 | 3,263 | 3,499 | 3,381 | 3,735 | 3,233 |
| | 42,282 | 44,575 | 44,587 | 47,899 | 42,865 | 48,147 | 53,949 | 55,628 |
| Fine foreign | 12,719 | 17,837 | 14,895 | 13,790 | 12,818 | 11,203 | 10,742 | 6,422 |
| Total | 55,001 | 62,412 | 59,482 | 61,689 | 55,683 | 59,350 | 64,691 | 62,050 |

*Chili.*—The following table gives the record of the exports of copper from Chili for a long series of years, no official statements of the production being available:

*Exports of copper from Chili.*

| Years. | Tons. | Years. | Tons. |
|---|---|---|---|
| 1855 | 20,250 | 1871 | 41,200 |
| 1856 | 21,958 | 1872 | 46,337 |
| 1857 | 25,498 | 1873 | 42,165 |
| 1858 | 30,470 | 1874 | 48,240 |
| 1859 | 28,250 | 1875 | 45,430 |
| 1860 | 36,289 | 1876 | 50,740 |
| 1861 | 38,371 | 1877 | 45,400 |
| 1862 | 43,109 | 1878 | 46,770 |
| 1863 | 32,540 | 1879 | 49,390 |
| 1864 | 47,500 | 1880 | 42,990 |
| 1865 | 48,327 | 1881 | 38,030 |
| 1866 | 44,820 | 1882 | 42,960 |
| 1867 | 44,654 | 1883 | 41,229 |
| 1868 | 43,669 | 1884 | 43,700 |
| 1869 | 54,867 | 1885 | 38,500 |
| 1870 | 49,130 | | |

Until the middle of the year 1885 exchange declined almost as heavily as the price of copper in London, and the result was that the producers in Chili did not feel it as did the miners in every other country. From January, 1883, when exchange was 37*d.*, it fell in August, 1885, to 23*d.*, a decline of 38 per cent. In the same period Chili bars in London dropped from £65 10*s.* to £42 5*s.*, or 35½ per cent., so that copper in Valparaiso rose from $17.95 to $18.70 per quintal. Early in March, 1886, the price had reached $15.80, while exchange advanced to 25½*d.* Advices of that date from a leading authority in Chili represent that such prices must rapidly affect adversely the productive capacity of the country.

*Spain.*—An interesting estimate of the actual output of copper in the Peninsula, including the fine copper both in precipitate and pyrites, has

been made by Messrs. H. R. Merton & Co., of London, who place the product as follows:

*Copper production of Spain and Portugal.*

| Mines. | 1885. | 1884. | 1883. | 1882. | 1881. | 1880. | 1879. |
|---|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Rio Tinto (Spain) | 23,484 | 21,564 | 20,472 | 17,389 | 16,666 | 16,215 | 13,751 |
| Tharsis (Spain) | 11,500 | 11,800 | 9,800 | 9,000 | 10,203 | 9,151 | 11,324 |
| Mason & Barry (Port) | 7,000 | 7,500 | 8,000 | 8,000 | 8,170 | 6,603 | 4,692 |
| Sevilla (Spain) | 1,800 | 2,000 | 2,026 | 1,885 | 1,340 | 1,705 | 1,360 |
| Portugueza (Port) | 1,665 | 2,300 | 2,357 | 1,700 | 1,410 | 1,000 | 770 |
| Poderosa (Spain) | 500 | 500 | 1,000 | 800 | 800 | 800 | 800 |
| Total | 45,949 | 45,664 | 43,655 | 38,774 | 38,589 | 35,474 | 32,697 |

The Rio Tinto mines continue to excite the greatest interest as among the greatest of the world. Their production for a series of years has been as follows:

*Production of the Rio Tinto mines.*

| Years. | Pyrites for shipment. | For extraction of copper by local treatment. | Total. | Actual consumption of pyrites in England, Germany, etc. | Average copper contents of ore mined. |
|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Per cent.* |
| 1877 | 251,360 | 520,391 | 771,751 | ..... | ..... |
| 1878 | 218,818 | 652,289 | 871,107 | ..... | ..... |
| 1879 | 243,241 | 663,359 | 906,600 | 236,849 | ..... |
| 1880 | 277,590 | 637,567 | 915,157 | 274,201 | 2.619 |
| 1881 | 249,098 | 743,949 | 993,047 | 256,827 | 2.750 |
| 1882 | 259,924 | 688,307 | 948,231 | 292,826 | 2.805 |
| 1883 | 313,291 | 786,682 | 1,099,973 | 288,104 | 2.956 |
| 1884 | 312,028 | 1,057,890 | 1,369,918 | 314,751 | 3.234 |
| 1885 | 406,772 | 944,694 | 1,351,466 | 354,501 | 3.102 |

The production of copper by local treatment at the Rio Tinto mines was as follows since 1876:

*Production of metallic copper at Rio Tinto.*

| Years. | Long tons. |
|---|---|
| 1876 | 946 |
| 1877 | 2,495 |
| 1878 | 4,184 |
| 1879 | 7,179 |
| 1880 | 8,559 |
| 1881 | 9,466 |
| 1882 | 9,740 |
| 1883 | 12,295 |
| 1884 | 12,668 |
| 1885 | 14,593 |

In spite of this increase in the production both of pyrites for shipment, and of copper by extraction, the profits have fallen off heavily, and it should be specially noted that while the make in 1885 had risen to 14,593 tons the sales were 16,246.

The profit on sale of produce, the net profit, and the dividends paid were as follows from 1879 to 1884, inclusive:

| Years. | Profit on sale of produce. | Net profit. | Dividends. | Dividends. |
|---|---|---|---|---|
| | | | | *Per cent.* |
| 1879 | £443, 930 | £114, 419 | £112, 500 | ..... |
| 1880 | 611, 340 | 181, 783 | 180, 000 | ..... |
| 1881 | 622, 786 | (a)405, 456 | 395, 000 | ..... |
| 1882 | 698, 985 | 477, 184 | 455, 000 | 14 |
| 1883 | 691, 571 | 459, 678 | 455, 000 | 14 |
| 1884 | 472, 326 | 191, 775 | 178, 750 | 5½ |

*a* Including £80,000 reserved from premiums on new issue of shares.

The year 1885 was one of disappointment so far as the sales of pyrites were concerned, since the actual sales fell nearly 50,000 tons behind the quantity estimated during the year. Nor did the output of copper come quite up to expectations. The aim of the management is to reach 20,000 tons of 21 hundred weights, and one of the principal obstacles to attaining that end, the accumulation of a sufficiently abundant water supply, has been overcome by the completion of the great dam some years since. During 1885 the rainfall was abundant, so that a greater output can be handled during the summer of 1886. Substantially no change has taken place in 1885 in the bonded debt of the company, which at the close of that year stood £2,309,820 of 5 per cent. bonds issued in 1880, and £1,177,500 of 5 per cent. bonds, issued 1884, the amount redeemed in 1885 being £53,720. The annual interest charge is therefore £174,366, which must be met before any dividends can be paid on £3,250,000 of stock. Among its reserves the company counts 64,643 tons of copper in the heaps undergoing treatment at the mines, which stand on the books at £6 11*s.*, on which the only cost is that of precipitation, estimated at £15 per ton. The company has leased refining works at Cwm Avon, in South Wales.

The second great pyrites company of Spain, the Tharsis Sulphur and Copper Company limited, has similarly felt the effect of a forced lowering of the price of pyrites through the encroachments of the Solvay soda process and the decline in the value of copper. It has also been touched by the lower prices of iron ore, the residue from roasting the pyrites in sulphuric acid manufacture, and of silver, which is extracted from the burnt pyrites.

The following table gives an epitome of the business during the past four years:

*Operations of the Tharsis Company.*

| Years. | Ore raised. | Pyrites shipped. | Precipitate shipped. | Net profits. | Dividends. |
|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | | |
| 1882 | 486, 860 | 218, 218 | 5, 534 | ..... | ..... |
| 1883 | 490, 033 | 202, 318 | 6, 717 | 334, 492 | 323, 032 |
| 1884 | 518, 552 | 206, 939 | 7, 095 | ..... | ..... |
| 1885 | 587, 303 | 311, 151 | (a)6, 110 | 104, 211 | 117, 466 |

*a* Larger quantity in stock at mines; total product of fine copper somewhat greater than 1884.

Like the Rio Tinto company, the Tharsis has large waste heaps, from which during 1885 about 1,000 tons of copper were extracted. Unlike the larger concern it does not, however, carry the copper contents thus in reserve as an asset. Unlike it, also, it treats itself a large proportion of its pyrites, selling the copper, the "blue billy," and the silver. During the past four years the company has been paying off a debenture debt of £400,000. Now it is proposed to reissue a similar amount, mainly to provide for the extension of the Huelva Tharsis railroad from the Tharsis to the Calanas mines which are being prepared for an increased output.

*Portugal.*—The most important producer is the Mason & Barry Company, limited, which works the San Domingos mine. According to the annual report for the year 1885, the amount of ore broken and extracted was 1,033,524 tons from 1878 to 1880, 352,439 tons in 1881, 405,029 tons in 1882, 382,555 tons in 1883, 344,459 tons in 1884, and 350,387 tons in 1885. In the beginning of 1885 the company decided to treat locally for the extraction of copper the whole quantity of ore broken, and therefore the ore sold for its sulphur value are "smalls," low in copper. The company claims that for their sulphur contents these smalls are superior to the lump ore. The price fixed for it is 3½ *d.* and 4 *d.* per unit, according to locality, if sold in England, under the condition that the burnt ore is returned to the company, who then, at their Wallsend works first wash out the small remaining portion of copper and then turn the residual iron ore into a form suitable for use in the blast furnaces. This, it will be noted, is an entire change of base, since it transfers the operation of copper extraction from the works scattered in England and the Continent to the mines in Portugal. To some extent the Rio Tinto Company is doing the same. Mason & Barry increased their production of copper precipitate from 4,860 tons in 1882 to 5,970 long tons, fine copper, in 1883, and to 6,190 long tons, fine copper, in 1884. This is, of course, exclusive of the copper contents of the pyrites shipped. Mr. John C. Barry, secretary, informs this office that in 1885 the copper product of the San Domingos fell off. He estimates the production in fine copper in precipitate and ore at about 7,000 long tons for 1885.

From 1878 to 1884, both years included, the net profits aggregated £1,463,163, out of which there was paid in dividends £1,243,308 on 185,164 shares allotted, at the rate of 12½ per cent. in the years 1881, 1882, and 1883. In 1884 it was reduced to 8 per cent. In 1885 the net revenue applicable to dividends was only £90,340 as against £173,510, and the profits obtained by shareholders fell to 3¾ per cent. per annum.

The following summary gives the capital of these three great companies early in 1886:

*Capital in* 1886.

| Company. | Shares. | Bonds, &c. | Total. |
|---|---|---|---|
| Rio Tinto | £3, 250, 000 | £3, 487, 320 | £6, 737, 320 |
| Mason & Barry | 1, 851, 640 | ..... | 1, 841, 640 |
| Tharsis | 1, 174, 660 | 319, 930 | 1, 494, 590 |
| Totals | 6, 276, 300 | 3, 807, 250 | 10, 073, 550 |

*Dividends paid on the net revenue applicable thereto.*

| Company. | Dividends. | | | Revenue applicable to dividends. | |
|---|---|---|---|---|---|
| | 1885. | 1884. | 1883. | 1885. | 1884. |
| | *Per cent.* | *Per cent.* | *Per cent.* | | |
| Rio Tinto | 5½ | 8 | 14 | £191, 774 | £274, 142 |
| Mason & Barry | 3¾ | 8 | 12½ | 90, 340 | 173, 510 |
| Tharsis | 10 | 20 | 27½ | 104, 212 | 273, 148 |

This shows a decline in the profits in one year of £298,474, or 43½ per cent.

*Germany*.—The German copper production has held its own during the past few years. That of 1885 is unofficially estimated at 15,250 long tons, an increase of less than 500 tons.

*Production of copper in Prussia and in the Mansfeld district.*

| Years. | Prussia. | Mansfeld district. |
|---|---|---|
| | *Metric tons.* | *Metric tons.* |
| 1875 | 7, 212 | 6, 046 |
| 1876 | 8, 235 | 6, 287 |
| 1877 | 8, 412 | 6, 908 |
| 1878 | 9, 096 | 8, 007 |
| 1879 | 9, 610 | 8, 526 |
| 1880 | 13, 605 | 9, 814 |
| 1881 | 14, 626 | 11, 000 |
| 1882 | (*a*)16, 653 | 11, 691 |
| 1883 | (*a*)18, 194 | 12, 836 |
| 1884 | (*a*)16, 825 | 12, 774 |
| 1885 | ..... | 12, 635 |

*a* German Empire, assuming matte produced to carry 50 per cent. of copper.

The last annual report of the Mansfeld'sche Kupferschieferbauende Gewerkschaft, for 1884, kindly forwarded by that company, is of special interest, because it ranks high in the list of the giants of the copper trade, and is probably without a rival as a carefully managed concern. The year 1884 was one of hardships growing out of a breaking through of water into an important district, and while the disaster was not threatening to the future of that district, it involved a heavy outlay for additional machinery and more pumping, and decreased the output of

ore and its grade, because it was necessary in order to give employment to the miners to put them into stopes carrying poorer ore. This led to a decline in the production from 536,085 tons of ore to 522,181 metric tons in 1884. It increased the cost of mining by 2,116,252 marks, the expenditures for dead work by 403,090 marks, and for new construction by 406,690 marks. These increased expenditures were partly balanced by a greater yield of silver, by the sale of stocks of copper, the cost of which had been charged to 1883 accounts, and by reductions in smelting costs. The sales of copper were made at comparatively favorable terms; the average for 1884 being 122 marks per 100 kilograms, equal to £61 per long ton. The result was that the falling off in the receipts amounted to only 671,240 marks. The gross profits for the year amounted to 5,675,734 marks, which was reduced by writing off for value of supplies, cost of flooding, and expenditure for two new shafts to 3,352,420 marks, out of which a dividend of 45 marks on 69,120 shares, equal to 3,110,400 marks, was declared. Referring this profit to copper alone, it represents 26.5 marks per 100 kilograms; or roughly £13 per long ton, the bulk of which would be swept away in 1885 by the decline in prices. The company had obligations outstanding to the amount of 9,759,000 marks at the end of 1884. Its assets, exclusive of value of mines and works, are estimated at 31,867,724 marks, so that it is financially strong enough to weather any storms which may threaten the copper producers of the world.

The cost of mining is placed at 32.73 marks per ton, an increase of 5 marks per ton as compared with the preceding year. Labor is very cheap, the average earnings of the miners on contract in the "upper" district being, in 1884, 3.07 marks, or 74 cents per eight-hour shift, and 2.98 marks, or 71 cents in the "lower" district. When it is considered that the bed is so narrow that the miners cannot sit erect in the workings, and that the ore is carried to the main gangways by boys crawling on their sides dragging a sled strapped to the leg, it will be appreciated how low their wages are. In producing the 505,797 tons in the Mansfeld district, 1,106,700 square meters of the bed were extracted, or nearly 2 meters, equal to 21½ square feet of the bed for every ton of ore. The blast furnaces of the company, some of which are blown with hot blast, smelted 517,633 tons of ore, which yielded 36,996 tons of raw matte. This ore averaged 2.592 per cent. of copper, against 2.611 per cent. in 1883, and 0.0154 per cent. of silver, or 4.49 ounces of silver per ton against 0.0152 per cent. in 1883. The roasting of the matte yielded 18,510 tons of chamber acid.

In 1885 the Mansfeld company produced 12,635 metric tons of copper and 75,075 kilograms of silver, the proceeds being 4,812,302 marks less than in the preceding year, leaving a loss of 653,338 marks. Out of the whole decline in the income 3,210,927 marks were due to lower prices realized for copper.

The following table shows the imports of copper and copper manufactures into Germany:

*Imports of copper and copper manufactures into Germany.*

| Character. | 1879. | 1880. | 1881. | 1882. | 1884. |
|---|---|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| Ingot copper and brass | 13,378 | 12,719 | 11,372 | 10,579 | 13,819 |
| Copper rods, sheet, and wire | 608 | 770 | 437 | 230 | 538 |
| Manufactured copper | 1,201 | 1,015 | 1,119 | 1,015 | 997 |
| Total | 15,187 | 14,504 | 12,928 | 11,824 | 15,354 |

The details of the source from which the copper was obtained throw no light on the matter, since a large share of the imports come in transit via Hamburg, the Netherlands, and Belgium. The following is the table, as given in the official imports statistics:

*Imports of copper into Germany.*

| Country. | 1884. | Eleven months, 1885. | Country. | 1884. | Eleven months, 1885. |
|---|---|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | | *Metric tons.* | *Metric tons.* |
| Hamburg-Altona | 2,075 | 1,681 | Great Britain | 6,935 | 5,708 |
| Austria-Hungary | 161 | 138 | United States | 417 | 668 |
| France | 358 | 231 | Other countries | 398 | 963 |
| Belgium | 1,002 | 963 | | | |
| Netherlands | 2,473 | 2,193 | Total | 13,819 | 12,545 |

Germany exports considerable copper, though not as much as she imports. According to the latest returns accessible for the first eleven months of 1885, the exports were:

*Exports of copper from Germany for* 1884.

| Country. | Ingots, and old. | Rods and sheets. | Wire and telegraph cable. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| Hamburg-Altona | 131 | 217 | 53 |
| Russia | 691 | 134 | 48 |
| Austria-Hungary | 4,065 | 67 | 135 |
| Switzerland | 119 | 118 | 64 |
| Belgium | 1,310 | 34 | 28 |
| France | 235 | ..... | 12 |
| Netherlands | 91 | 279 | 222 |
| Great Britain | 81 | 62 | 69 |
| Italy | 113 | 202 | 56 |
| United States | ..... | ..... | 23 |
| Other countries | 69 | 170 | 206 |
| Total | 6,905 | 1,283 | 916 |
| Eleven months, 1885 | 4,818 | 2,896 | ..... |

*France.*—The following is an official statement of the quantity of copper produced in French works from imported ores and furnace material, with the exception of a trifling quantity:

*Production of copper in France.*

| Years. | Metric tons. | Years. | Metric tons. |
|---|---|---|---|
| 1870 | 2,100 | 1877 | 2,330 |
| 1871 | 2,720 | 1878 | 3,500 |
| 1872 | 2,600 | 1879 | 3,350 |
| 1873 | 2,140 | 1880 | 3,300 |
| 1874 | 2,000 | 1881 | 3,395 |
| 1875 | 2,300 | 1882 | 3,627 |
| 1876 | 2,230 | 1883 | 3,255 |

The following figures, compiled by English authorities, show the magnitude of the French copper trade:

*The French copper trade.*

| Years. | Imports, all kinds direct. | Imports of American, etc. | Imports of Chili. |
|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* |
| 1876 | 16,418 | 4,220 | 12,198 |
| 1877 | 13,015 | 4,030 | 8,985 |
| 1878 | 13,094 | 4,016 | 9,078 |
| 1879 | 10,402 | 4,675 | 5,727 |
| 1880 | 11,818 | 320 | 11,498 |
| 1881 | 16,436 | 3,205 | 13,231 |
| 1882 | 13,573 | 1,379 | 12,194 |
| 1883 | 20,894 | 4,830 | 16,064 |
| 1884 | 18,683 | 7,597 | 11,086 |
| 1885 | 15,592 | 9,235 | 6,357 |

*Russia.*—While the yield of the copper mines in the Oural mountains has been declining, increased attention is being paid to some extent by foreign capitalists to the copper resources of Trans-Caucasia. A report by M. de Fulgence, French vice-consul at Batoum, to his government, refers to the latter at length. The mines of the Tchorok group are not regarded by him as being of early promise on account of the lack of means of transportation, and the want of fuel. Rich ores characterize the Zanguezour group, between Ordoubât and Nakhitchevan, on the left bank of the Araxe, but as the region is so remote from market, the product is only about 300 metric tons, for local consumption. In the Alaverdy district, favored by its proximity to Tiflis, the Alaverdy, Akhtal, and Chamblouk works have closed down because the mines have been robbed. In the Elizabethpol district, the Siemens brothers, the well-known manufacturers of telegraph cables, are operating the Kedabek and Kalakent works, producing in 1884 from 17,000 tons of ore, 1,100 metric tons of copper, at an estimated cost of 110 francs per ton. The copper must be taken by carts to Chamkor and is delivered by rail to Bakou. The exhaustion of the timber

resources has led to efforts to use Russian petroleum as a fuel. The most promising of the Trans-Caucasian copper districts yet undeveloped, is the Kakhetie group in the Alezane valley, near Telav. German capital is going into mining there.

Official statistics published in 1884 place the copper product of Russia at the following figures, for a series of years:

*Production of copper in Russia.*

| Years. | Metric tons. |
|---|---|
| 1876 | 3,876 |
| 1877 | 3,507 |
| 1878 | 3,522 |
| 1879 | 3,126 |
| 1880 | 3,205 |
| 1881 | 3,467 |
| 1882 | 3,595 |

*Austria.*—From official sources the following table of the output of the Austrian mines is compiled:

*Production of copper in Austria.*

| Years. | Metric tons. |
|---|---|
| 1879 | 259 |
| 1880 | 500 |
| 1881 | 482 |
| 1882 | 482 |
| 1883 | 581 |
| 1884 | 681 |

*Cape of Good Hope.*—The Cape Copper Mining Company, limited, has, judging from estimates of receipts in England during 1885, fallen off in production by over 600 tons. In 1884, according to the annual report submitted for that year, the receipts were £264,360, for ore averaging 29.25 per cent., at the rate of 9*s.* 3*d.* per unit. The costs and expenses were £203,672, thus showing a net profit of £60,688, equivalent to about £10 14*s.* per long ton of fine copper. In 1884 sufficient sums were drawn from the profit reserve fund to pay dividends and a bonus aggregating £90,000. The decline in the price of copper during 1885 has been so heavy that the profits realized last year must have been reduced to a very low figure, if indeed they have not entirely disappeared. The principal mine is the Ookiep, from which 17,495 tons were obtained, partly from surface reserves however. The old Specktakel mine was closed down in 1885, and the developments, according to the last annual report, did not, in any of the company's properties, disclose any large new bodies. The reserves in the Ookiep mine at the close of 1884 were estimated at 51,312 tons of ore.

*Venezuela.*—Mr. William Warren, chief resident engineer of the Quebrada Railway, Land and Copper Company, limited, reports to this office the following as the accurate exports of copper from Venezuela:

| Years. | Yellow, ruby, and other ores. | Regulus. | Total units of fine copper. |
|---|---|---|---|
| | *Long tons.* | *Long tons.* | |
| 1885 | 42,939 | 2,586 | 560,833 |
| 1884 | 30,537 | 6,259 | 523,514 |
| 1883 | 30,392 | 3,234 | 422,135 |
| 1882 | 28,045 | 3,072 | 418,030 |
| 1881 | 22,107 | 2,880 | 339,256 |

The bulk of this material was shipped to England, although some was sent to this country for treatment.

# LEAD.

## THE LEAD INDUSTRY OF THE UNITED STATES.

By C. Kirchhoff, Jr.

The year 1885 has witnessed one of the revulsions in the lead trade which it has repeatedly experienced in the last fifty years. The approaching exhaustion of a number of the heaviest lead-producing mines in the Rocky mountains had its effect in curtailing supplies, although to some extent this was compensated for by the output of mines furnishing an ore high in lead and low in silver, serving merely as the basis of smelting operations. Under a moderate consumptive demand, the country was gradually relieved of pressing stocks; and, when they were largely cleared away, prices steadily rose during the second half of the year until finally the import limits were exceeded, and moderate quantities of foreign lead were needed to cover the deficiency. The high prices for lead came too late in the year to have a strongly stimulating effect upon the output. The product of a large proportion of the leading districts has for some time been regulated rather by the demands of smelters for lead ores, who, during the greater part of the year, even before the advance, paid more for the metal in the ore than they could possibly realize for it in the markets of the country. Notably in the Leadville district, therefore, conditions independent of the price of lead have stimulated the output during the year, and while it is to be expected that the higher prices established towards the end of the year will act as an incentive to vigorous mining, the effect will not be so great as it would otherwise have been had the returns received for lead in the ores been affected solely by the fluctuations of the metal in the great distributing centers. Though still dependent very largely upon the prosperity of individual mines, which may be counted on one's fingers, a far larger proportion of the make is due to the operations of small mines and of low-grade ores than was the case ten years ago. The industry has broadened, and to that extent has become less susceptible to the vicissitudes of individual mines or of single districts. The unexplored territory has been narrowed down considerably. The chances of the discovery of new districts capable of flooding the markets at short notice have been reduced to a minimum, and it is more possible than ever before to gauge the probable supplies for at least moderately long periods in advance. An interesting example is furnished by the estimate made by Mr. D. Bauman of the prospects of Colorado for the current year. On the other hand, it should not be forgotten that comparatively little has been done in an era of depression in railroad building to make new productive sections available. Of late

a little more activity has been displayed in this direction. So far as known, none of the lines in course of construction or in contemplation will open out sections capable of quickly furnishing very large supplies. But they will nevertheless enlarge the productive capacity, or fill gaps caused by the decline in other older sections.

In a general way it may be stated that costs have been little affected by the developments of the year 1885. Wages have practically remained the same. Fuel has been lowered in some instances and freights have occasionally declined, but there has been no change so marked as to justify the assertion that the cost per pound delivered at distributing centers has been much lower.

Attention has been called in former reports to the interdependence of silver and lead mining in the Rocky mountains. It has been repeatedly asserted in the past, and this has been true to a certain extent, that lead was merely a by-product in the extraction of silver. If the ground were taken that without its silver contents the lead could not have been profitably worked, then that view of the case would be correct, and even to-day the output would be insignificant under those conditions. But a change has taken place in this respect. A decade since, smelting works, owned and operated by the leading mining companies themselves, could only treat ores carrying both a high percentage of lead and silver. Now the bulk of the ore is smelted by custom smelters who buy both lead ores low in silver and silver ores low in lead. A scarcity of the former forces prices to a point when practically a premium is paid on the metal. A decline in the price of silver, such as has taken place during 1885 and is still continuing, discourages the output of the second class, since a considerable proportion of that which reaches the open market leaves only a narrow margin to the miner. Until now the buyers of lead ores have recouped themselves by profits realized by working the other class. A fall in silver has therefore the tendency to make work less profitable in those mines yielding both metals, and by narrowing the market of purely silver ores, it acts too in the direction of lessening the call for lead ores carrying little or no silver. It is impossible to give numerical expression to this change, but it is generally accepted as having wrought a complete revolution in the trade. An effort to obtain the figures would involve the study of every ore shipment to the different smelters. It may be stated, however, that returns from desilverizing works whose aggregate product was 105,142 tons of refined lead showed a total yield of 25,834,684 ounces of fine silver and 153,642 ounces of fine gold. In 1884 the reports covered 117,608 tons of lead, 21,505,248 ounces of fine silver, and 146,830 ounces of fine gold.

### PRODUCTION.

The following table of the production of lead for a long series of years shows that the output of that metal reached its climax in the year 1883, and that it has since steadily declined. The figures from 1825 to 1853 are those published by Whitney; those of the later years have been col-

lected by Mr. Edward A. Caswell, of New York city. Since 1882 the figures are those collected by this office.

Up to the year 1873 no specific data concerning the relative output of the different producing districts were available. For the succeeding years the quantities of desilverized lead and of non-argentiferous lead and the percentage of the former of the total have been added because they reveal clearly the growing importance of the former industry, which has its seat in the Rocky mountains; while almost the whole of the non-argentiferous lead is produced in Missouri, Kansas, Illinois, and Wisconsin, only a small quantity being made in Virginia. In this table, and throughout this paper, the tons are short tons of 2,000 pounds.

*Production of lead in the United States.*

| Years. | Total production. | Desilverized lead. | Non-argentiferous lead. | Percentage of desilverized lead. |
|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* | *Per cent.* |
| 1825 | 1,500 | | | |
| 1830 | 8,000 | | | |
| 1831 | 7,500 | | | |
| 1832 | 10,000 | | | |
| 1833 | 11,000 | | | |
| 1834 | 12,000 | | | |
| 1835 | 13,000 | | | |
| 1836 | 15,000 | | | |
| 1837 | 13,500 | | | |
| 1838 | 15,000 | | | |
| 1839 | 17,500 | | | |
| 1840 | 17,000 | | | |
| 1841 | 20,500 | | | |
| 1842 | 24,000 | | | |
| 1843 | 25,000 | | | |
| 1844 | 26,000 | | | |
| 1845 | 30,000 | | | |
| 1846 | 28,000 | | | |
| 1847 | 28,000 | | | |
| 1848 | 25,000 | | | |
| 1849 | 23,500 | | | |
| 1850 | 22,000 | | | |
| 1851 | 18,500 | | | |
| 1852 | 15,700 | | | |
| 1853 | 16,800 | | | |
| 1854 | 16,500 | | | |
| 1855 | 15,800 | | | |
| 1856 | 16,000 | | | |
| 1857 | 15,800 | | | |
| 1858 | 15,300 | | | |
| 1859 | 16,400 | | | |
| 1860 | 15,600 | | | |
| 1861 | 14,100 | | | |
| 1862 | 14,200 | | | |
| 1863 | 14,800 | | | |
| 1864 | 15,300 | | | |
| 1865 | 14,700 | | | |
| 1866 | 16,100 | | | |
| 1867 | 15,200 | | | |
| 1868 | 16,400 | | | |
| 1869 | 17,500 | | | |
| 1870 | 17,830 | | | |
| 1871 | 20,000 | | | |
| 1872 | 25,880 | | | |
| 1873 | 42,540 | 20,159 | 22,381 | 47.7 |
| 1874 | 52,080 | | | |
| 1875 | 59,640 | 34,909 | 24,699 | 58.5 |
| 1876 | 64,070 | 37,649 | 26,421 | 58.8 |
| 1877 | 81,900 | 50,748 | 31,152 | 62.0 |
| 1878 | 91,060 | 64,290 | 26,770 | 70.6 |
| 1879 | 92,780 | 64,650 | 28,130 | 69.7 |
| 1880 | 97,825 | 70,135 | 27,690 | 71.7 |
| 1881 | 117,085 | 86,315 | 30,770 | 73.7 |
| 1882 | 132,890 | 103,875 | 29,015 | 78.3 |
| 1883 | 143,957 | 122,157 | 21,800 | 84.8 |
| 1884 | 139,897 | 119,965 | 19,932 | 86.4 |
| 1885 | 129,412 | 107,437 | 21,975 | 83.0 |
| Total | 2,002,546 | | | |

The figures for the output of desilverized lead are the aggregates of the returns made by every desilverizing works in the country. This system of depending upon the refiners for the record of output has been accepted by this office because it gives the certainty that the figures of small smelters working intermittently at many points in the Rocky mountains are included. It affords the closest approximation, furthermore, to the amounts actually available for consumption since the aggregate of the smelters' returns would be too great. Thus alone the silver contents of base bullion would call for an allowance of nearly 700 tons, and the waste due to refining and the removal of antimony, arsenic, copper, and other impurities, would require a further deduction of at least 4 per cent. Thus, to produce 107,437 tons of refined lead, the smelters' returns would have to show roughly 112,500 tons. The presentation of that figure would be very misleading. On the other hand, the output of the refiners may not correctly express the real make of lead in the country. The desilverizing works may have entered the year carrying a greater or smaller stock of base bullion than they did at its close, and the same may be true of the smelters, who in addition thereto may have worked partly on stocks of ore. The result may be that the output of refined lead may considerably over or under state the actual extraction of lead from the mines of the country. This is known to have been true in the year 1885. Notably, some of the Leadville smelters carried over 1884 output forwarded to market in 1885, so that the actual product of the country was even somewhat less than the return shows. It is estimated that therefore it was not more than 127,000 to 128,000 tons, indicating even a heavier decline than the face of the returns shows.

During the year 1885 the interchange of ores from one Territory or State to another has grown so much through the concentration of smelting operations in a few leading sections, and through the growth of the smelting operations at refining works, that an attempt to trace the lead to its source had to be abandoned. The ore passes through so many hands in many cases that its identity can be traced only by a laborious investigation which would involve too great a demand upon the time of those interested. This is much to be regretted because it makes it all the more difficult to trace the changes in the relative importance of different sections as producers. Some general data bearing upon this subject will, however, be found elsewhere. It may be stated, however, that Colorado and Utah bear between them by far the greatest proportion of the decline. The last estimate is repeated for the sake of affording some idea of the magnitude of lead mining in different States and Territories.

*Source of the lead produced in the United States in* 1883, 1884, *and* 1885, *by States and Territories.*

| States and Territories. | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* |
| Utah | 29,000 | 28,000 | 23,000 |
| Nevada | 6,000 | 4,000 | 3,500 |
| Colorado | 70,557 | 63,165 | 55,000 |
| Montana | 5,000 | 7,000 | (?) |
| Idaho | 6,000 | 7,500 | (?) |
| New Mexico | 2,400 | 6,000 | 5,000 |
| Arizona | 1,500 | 2,700 | 3,000 |
| California | 1,700 | 1,600 | 1,000 |
| Missouri, Kansas, Illinois, and Wisconsin | 21,600 | 19,676 | 21,650 |
| Virginia | 200 | 256 | 250 |
| Total | 143,957 | 139,897 | 112,400 |

LEAD-PRODUCING REGIONS OF THE UNITED STATES.

*Utah.*—For a series of years, the production of the Territory has been estimated as follows:

*Production of lead in Utah.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1871 | 5,000 | 1879 | 14,000 |
| 1872 | 8,000 | 1880 | 15,000 |
| 1873 | 15,000 | 1881 | 24,000 |
| 1874 | 20,000 | 1882 | 30,000 |
| 1875 | 19,000 | 1883 | 29,000 |
| 1876 | 25,000 | 1884 | 28,000 |
| 1877 | 27,000 | 1885 | 23,000 |
| 1878 | 21,000 | | |

According to the statement of Messrs. Wells, Fargo & Co., the product of Utah was as follows:

*Wells, Fargo & Co.'s statement of the product of Utah for* 1885.

| Base bullion. | Unrefined lead. | Fine silver. | Fine gold. |
|---|---|---|---|
| | *Pounds.* | *Ounces.* | *Ounces.* |
| Germania Lead works | 7,975,400 | 629,754 | 1,404 |
| Hanauer | 9,352,644 | 666,685 | 2,158 |
| Horn Silver Mining Company (three months) | 4,905,932 | 123,062 | ..... |
| Mingo Furnace Company | 11,744,000 | 403,081 | 1,586 |
| Net product base bullion | 33,977,976 | 1,822,582 | 5,148 |
| Lead, silver, and gold in ores shipped | 20,340,800 | 1,366,994 | 2,141 |
| Total | 54,318,776 | 3,189,576 | 7,289 |

The Germania lead works, and the Hanauer and Mingo works are custom smelters, drawing supplies largely from Idaho, and to some extent from Montana. Since no data are available concerning the proportion of their output of 15,536 tons, which originated outside of Utah, it is impossible to give the net amount really coming from that Territory. It is probably in the neighborhood of 23,000 tons.

The tonnage of the different districts has been estimated as follows:

| District. | Tons. |
|---|---|
| Cottonwood | 1,800 |
| Bingham | 22,500 |
| Toolee | 10,000 |
| Tintic | 34,000 |
| Beaver | 15,000 |
| Park City | 20,000 |

The principal event of the year 1885 was the closing down on April 1 of the Horn silver mine, whose product therefore declined from about 15,000 tons in former years to only about 2,500 tons. During the year, however, the Horn silver mine is estimated to have marketed, besides their product, an old stock amounting to about 2,500 tons. So heavy a falling off in the product of one mine, with slight prospects of an early return to productiveness, was largely responsible for the reduced output of lead in the United States in 1885. The advance in the price of lead has, however, given an impetus to mining in all of the silver-lead ore producing districts of Utah. Many small mines on which work had been suspended for years were reopened during the second half of 1885, and thus kept up fairly well the aggregate of the lead product of the Territory.

In Little Cottonwood the Joab Lawrence mined 1,200 tons of ore, and the Big Cottonwood and the Maxfield produced considerable quantities towards the close of the year. Bingham has profited by the advance in lead more than any other district, since the chief value of its low grade ores lies in that metal. The Brooklyn is the principal producer, having shipped about 9,000 tons, followed by the Lead mine and the Yosemite. Among the mines of Toolee county which show increased activity, are the Honorine and the Calumet at Stockton; the Hidden Treasure, in Dry Cañon; and the Stanton and Miners' Delight at Ophir. As indicating the effect of higher lead prices, it may be stated that the ore shipments over the Utah and Nevada railroad rose from 2,646 short tons in the first half of 1885 to 6,874 tons in the second half. During the latter part of 1885, the Waterman smelter was made ready for work. In the Tintic country the Eureka Hill has shipped 11,300 tons, and the Bullion, Beck, and Champion 11,840 tons, both running low in lead, however.

One of the most striking instances of shipments to smelters on the part of what were formerly classed as silver mines is furnished by the Ontario mine. In addition to crushing large quantities in its own stamp mills, this company sold 8,752 tons of ore to smelters containing 1,361 tons of lead, 809,621 ounces of silver, and 700 ounces of gold.

The Crescent, at Park City, which has large bodies of low-grade ores, produced in eleven months of its fiscal year (ending September 30) 11,581 tons of ore netting $199,413, the ore averaging 30 per cent. of lead.

The Sampson, near the Crescent, has sent to market about 1,300 tons of 25 per cent. ore.

*Nevada.*—Since 1877 the production of lead in the State has been as follows:

*Production of lead in Nevada since* 1877.

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1877 | 19,724 | 1882 | 8,590 |
| 1878 | 31,063 | 1883 | 6,000 |
| 1879 | 22,805 | 1884 | 4,000 |
| 1880 | 16,659 | 1885 | 3,500 |
| 1881 | 12,826 | | |

The only district of importance, furnishing almost the entire product, is the Eureka, in which the Eureka Consolidated and the Richmond companies are the principal producers. The following data, taken from the last annual reports of these companies, will furnish some idea of the conditions affecting the district generally:

The Richmond desilverizing works turned out in 1885, 1,657 tons of refined lead, 418,000 ounces of silver, and 13,085 ounces of gold. According to the annual report, for the fiscal year ending February 28, 1886, the company smelted 7,559 tons of Richmond ore and 7,493 tons of purchased ores, which yielded 2,045 short tons of lead, 444,368 ounces of silver, and 13,163 ounces of gold. At the commencement of the fiscal year the company was carrying 11,644 tons, and sold 7,538 short tons, leaving an estimated stock of about 6,000 tons.

A small quantity of lead has been produced by the Eureka and at the smelter of the Wells company in Elko county. It has been proposed to enlarge the smelting facilities of the latter during the current year. The total product of the State has therefore remained very moderate, nor do the developments to date hold out any promise of increased supplies from that source.

*Colorado.*—This State has remained the heaviest contributor to the supply of lead of this country.

*Production of lead in Colorado.*

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1873 | 56 | 1880 | 35,674 |
| 1874 | 312 | 1881 | 40,547 |
| 1875 | 818 | 1882 | 55,000 |
| 1876 | 667 | 1883 | 70,557 |
| 1877 | 897 | 1884 | 63,165 |
| 1878 | 6,369 | 1885 (smelter's base bullion product) | 66,251 |
| 1879 | 23,674 | | |

The total given for 1885 is the output of all the smelters in Colorado. How large a proportion of the lead thus credited to that State is in reality from other quarters may be conceived when it is stated that out of the whole published figures, covering the operations of the

Omaha and Grant Smelting and Refining Company, of 13,827 short tons not less than 8,423 short tons were from States and Territories other than Colorado. It is probable that the actual lead product of the State did not exceed, if it did reach, 55,000 short tons.

The following figures relate to Leadville:

*Leadville bullion product.*

| Years. | Lead. | Silver. | Gold. | Ore. | Value of ore shipments. |
|---|---|---|---|---|---|
| | *Tons.* | *Ounces.* | *Ounces.* | *Tons.* | |
| 1877 | 175 | 376,827 | 3,750 | 3,300 | $400,000 |
| 1878 | 2,324 | 450,476 | 897 | 15,840 | 2,360,503 |
| 1879 | 17,650 | 6,004,416 | 1,100 | 18,549 | 2,851,850 |
| 1880 | 33,551 | 8,999,399 | 1,687 | 12,410 | 1,460,363 |
| 1881 | 38,101 | 7,162,909 | 12,192 | 15,630 | 1,016,044 |
| 1882 | 39,864 | 8,376,802 | 12,615 | 22,416 | 1,872,604 |
| 1883 | 36,870 | 5,057,990 | 22,330 | (?) | 6,420,692 |
| 1884 | 35,296 | 5,720,904 | 22,626 | (?) | (?) |
| 1885 | 19,128 | 5,099,271 | 8,262 | 137,869 | (?) |

The railroad shipments of bullion from Leadville during 1885 were 21,328 tons, thus showing that heavy stocks held in the beginning of the year were cleared away in the course of 1885. The railroad shipments of ore were 137,869 tons. The *Herald-Democrat* estimates the contents of 132,000 tons shipped, at 16,972 tons of lead, 3,184,514 ounces of silver, and 24,440 ounces of gold. This would make Leadville's contribution 36,100 short tons, a falling off as compared with 1884.

Through the active competition of the smelters both at Leadville and in the "valley," Leadville has become, comparatively speaking, one of the most favorable ore markets, to the miner, in the world. This will be clearly apparent from the following quotations which have been the basis of transactions, during the year 1885. They represent the prices paid at Leadville, delivered at the sampling works. Classifying the ores we have:

(1) *Carbonate lead ores.*—The principal producers of this class of ore are the Iron Mining Company, the Silver Cord, Adams Mining Company, the Little Ella, the Carbonate Hill mines, among which are prominent: the Crescent, the Morning Star, the Evening Star, etc., and finally, a number of mines at Red Cliff, a tributary camp.

The highest bid for this class of ore has been: New York quotation for silver, less 5 per cent., $20 per ounce for gold, and 40 cents per unit, or each per cent., for lead, if under 40 per cent. of lead, and 45 cents per unit, if over 40 per cent. of lead, regardless of the actual New York price for lead. The bid provided that there be no smelting charge whatever.

The following is the general price list for lead ore during 1885:

Silver: New York quotation, less 5 per cent.

Gold: $19 per ounce, if over 0.1 ounce per ton.

Lead: 45 cents per unit, when the New York quotation of lead is 4.25 cents; 40 cents per unit, when the New York quotation of lead is under 4.25 cents.

*Working charges, per ton of 2,000 pounds, dry weight.*

| Kind of ore. | Charges. |
|---|---|
| On 30 per cent. lead ore | $3.00 |
| On 25 per cent. lead ore | 4.00 |
| On 20 per cent. lead ore | 5.00 |
| On 15 per cent. lead ore | 6.00 |
| On 10 per cent. lead ore | 7.00 |
| Under 10 per cent. lead ore | 8.00 |

(2) *Dry oxidized silver ores.*—The leading producers of this class of ore are the Matchless, the Forest City, the Denver City, the Robert E. Lee, the Silver, and the May Queen mines.

Silver: New York quotation, less 5 per cent.

Working charges: $12 per ton of 2,000 pounds.

(3) *Argentiferous iron ore.*—The leading mines which market this class of ore are the Morning Star, the Henriett, the Denver City, the Dunkin, the Robert E. Lee, and the Matchless. The following is the basis on which this ore is sold. The contents of the ore, in percentages, of metallic iron and of metallic manganese is added, and from this is deducted the contents, in per cent. of silica. The figure thus arrived at is called the "base excess," and the tariff standard is based on the assumption that this "base excess" is 40 per cent. The prices paid during 1885 were:

(*a*) For low grade iron ore, carrying 12 ounces of silver or less per ton:

Silver: 50 cents per ounce.

Working charge: none.

Iron: 10 cents added for each per cent. iron or manganese over 40 per cent. "base excess"; 10 cents deducted for each per cent. iron or manganese under 40 per cent. "base excess."

(*b*) For first-grade iron ore, carrying over 12 ounces of silver per ton:

Silver: New York quotation, less 5 per cent.

Working charge: $6 per ton.

Iron: 10 cents added for each per cent. iron or manganese over 40 per cent. "base excess," and 10 cents deducted for each per cent. iron or manganese under 40 per cent. "base excess."

(4) *Sulphurets carrying galena.*—The principal producers are the "Colonel Sellers" and the "Minnie" and the "A. Y." mines. The lowest price paid until March, 1885, was as follows:

Silver: 90 per cent. of New York quotations.

Lead: 25 cents per unit when the New York quotation is 4 cents for lead. Five cents per unit is added or deducted for each 5 cents per 100 pounds advance or decline in the New York quotation for lead.

Zinc: 12 per cent. is the standard. For each unit of zinc above the standard 50 cents is deducted.

Working charge: $21.50 per ton of 2,000 pounds.

The latest and highest prices paid in 1885 for this class of ore were the following:

Silver: 93 per cent. of New York quotations.

Lead: 35 cents per unit, when the ore contains 30 per cent. of lead, 40 cents per unit when the ore contains over 30 per cent of lead.

Zinc: Standard, 20 per cent. For each unit above 20 per cent. 50 cents is deducted.

*Working charges.*

| Kind of ore. | Charges. |
|---|---|
| | *Per ton.* |
| On 20 per cent. lead ore | $19.00 |
| On 20 to 25 per cent. lead ore | 18.00 |
| On 25 to 30 per cent. lead ore | 17.00 |
| On over 30 per cent, lead ore | 16.00 |

(5) *Sulphurets with no galena and little zinc.*—These ores, high in iron pyrites, which are produced by the Mike and Star mine, are sold on the following basis:

Silver: 95 per cent. of New York quotation.

Copper: $1 per unit.

Working charges: $13 per ton, free on board cars.

(6) *Sulphurets with no galena and* 10 *to* 15 *per cent. of zinc.*—This class of ore is produced chiefly by the Forepaugh mine, and is paid for at the following rates:

Silver: 95 per cent. of New York quotation.

Working charges: $15 per ton, free on board cars.

When it is considered that coke, containing 20 per cent. of ash, costs at Leadville $13 per ton, and that the cost of smelting, placing it at a low figure, is $8 per ton run of ore, it will be understood by an examination of the above figures that more is paid for the lead in the ores than can be recovered for it.

During the current year smelting charges have been more favorable thus far to the furnace men, without rising so much as to discourage mining.

Mr. D. Bauman, of Buena Vista, under date of January 26, has furnished an estimate of the probable output of lead ores in Colorado, based upon a careful study of the conditions existing at that time. Such an estimate is of course subject to many contingencies affecting individual producers, entire groups of mines or the whole industry. The total may be swelled by the striking of exceptionally high grade bodies of great magnitude, or by temptingly high prices. It may be diminished by accidents, labor troubles in allied industries or a decline in values. As it is however, it constitutes a thorough and clear review of the actual status of the industry of more immediate interest than a historical sketch of the happenings of the past year.

In Leadville the first group of mines to be considered is that of Main Fryer hill. The record of the Chrysolite, Little Chief, and Little Pitts-

burgh shows that whatever vitality they may possess as producers of dry and milling iron ores, their output will not be greater than 3,000 tons of lead ore, averaging 12 per cent. Adding 50 tons of 20 per cent. ore from a few smaller mines, a total of 370 tons of lead is reached. The product of the Matchless, New Pittsburgh, and Hibernia, on East Fryer hill, yielding ore of higher grade, is estimated at 750 tons of metallic lead contents. The mines on Yankee hill, of which the leading ones are the Moyamensing, May Queen, Forest City, Denver City, Lee Basin, Alleghany, Scooper, and Chieftain, carry but little lead in the siliceous and ferruginous ores they turn out. It is estimated that 300 tons of lead will cover the product.

The three sections of Leadville thus far mentioned are those lowest in lead, though their importance is great in other respects as producers of iron and dry chloride and iron sulphide ores. Those acquainted with that section look forward to the discovery of lead sulphide ores both on East Fryer and Yankee hills, but it is not believed that even if this possibility is verified that it will have any appreciable effect upon the current year's markets.

Carbonate hill is looked forward to as one of Leadville's chief sources of lead ore supply, and it is likely that fully nine-tenths of it will come from the Maid of Erin, Henriett, Brookland-Clontarf or Adams mines, the Wolf Tone-Agassiz, and Morning Star. It is believed that these mines combined will produce not less than 9,000 tons of metallic lead, provided the Maid of Erin and Henriett ship 10,000 tons of ore, which it is believed that they will do, though it is not likely that they will exceed it much. The Wolf Tone-Agassiz are counted upon to contribute a like amount to the market. A number of other mines, among them the Catalpa, Carbonate, Leadville, Glass-Pendery, Crescent, Ætna, Modest Girl, and a few others, may yield 200 tons of metallic lead. Thus far the preparations for treating the sulphides of Carbonate hill are not extensive, and until now the development of that class of ore in a large body has been limited to the Wolf Tone.

On Iron hill the mines of the Iron Silver Company, including its California Gulch properties, may be credited with an output of 24,000 tons, including concentrates, the whole averaging about 16 per cent., or 3,840 tons of metallic lead. The Silver Cord mines, which shipped last year nearly 10,000 tons, of which a large percentage was high-grade ores, now show more sulphides, which are too low to be marketed without previous concentration, which has not been provided for as yet. They will not, therefore, in 1886 occupy the same prominent position as contributors to the lead supply. On the other hand, another lead mine, called the Benton, has been opened in the rear of Iron Hill, in what is known as Adlaide Park. It is an extension of the regular deposits of the Park mine, which a few years since made considerable shipments. During the greater part of 1885 the Benton mine sent to market from 500 to 600 tons per month of ore carrying 36 per cent. of lead. It may

be credited with 4,000 tons of ore or 1,600 tons of lead in 1886, the policy of the management at present being rather to push development work than to extract ore. The Argentine, Terrible, Humboldt, Newton, and Silver Cord may be estimated at 1,000 tons of metallic lead. The Louisville, Colorado No. 2, and North Ruby may produce 7,500 tons of 30 per cent. ore. It is possible that the grade may be lower, but in that case it is likely that the tonnage will be heavier, so that the product of metal may be put at 2,250 tons. The Smuggler, Iron Hill Consolidated, and the A. Y. and Minnie mines may be relied upon for 6,000 tons of carbonates, equivalent to 1,200 tons of lead. The great sulphide deposits of the Colonel Sellers, A. Y., Minnie, Accident, Sierra Nevada, and Moyer, which form one enormous ore chute, believed to be continuous through the William Moyer placer, the eastern part of the Silver Cord, and the Ruby, is an uncertain element in the question. It depends upon the success of the concentrating works built already and the activity with which building of new works will progress during the year. The sales of ore of the Colonel Sellers mine and the output of its concentrating plant may be estimated at 18,000 tons, equivalent to 4,250 tons, and the yield of the A. Y. and Minnie mines may be placed at 3,000 tons of sulphides or 1,000 tons of metallic lead.

On Rock hill the Sullivan, Only Chance, and Emmet mines will produce not less than 7,000 tons of lead ore, aggregating 2,500 tons of lead. The La Plata, Crown Point, Pinnacle, Montgomery, Gilt Edge, Sequin, Pease, Willis, and Moyer properties are believed to be good for 10,000 tons of lead ore, carrying 2,500 tons of lead. The Lillian, Brian Boru, G. M., Favorite, and other mines of Printer Boy hill will in all likelihood yield about 5,000 tons of ore or 1,000 tons of lead. The Upper Iowa Gulch mines and Ball Mountain will probably not exceed 500 tons of lead ore or 200 tons of metal, and will do well if they produce that.

On Little Ellen hill the New Year property is known to contain large ore bodies, but it will hardly come into the market this year, since the incline being driven towards them will probably not reach it until the close of the year. All the other mines of this section, with the exception of the Little Ellen mine proper, have been poorly worked and are partly unsafe. So far as lead ore is concerned they are pockety. The Little Ellen and the majority of the other mines are worked by lessees. It is not likely that all of them together will ship more than 6,000 tons of ore or 1,200 tons of lead, unless the New Year mine begins active extraction earlier than expected.

Mount Sheridan, Sugar Loaf, Mount Kevin, and Frying Pan mines, in the vicinity of Leadville, may produce 300 tons of metallic lead.

The Red Cliff district, in Eagle county, is tributary to Leadville. The Iron Mask and Black Iron are the principal producers, and with the Little Chief, Ollie, Belden, Eagle Bird, and others, will turn out at least 11,000 tons of ore or about 3,500 tons of metallic lead.

At Aspen, in Pitkin county, a number of the principal mines have been consolidated as the Aspen Mining and Smelting Company, the aim of which will be to increase the smelting capacity and cheapen the transportation facilities with the coal mines controlled by it. It is believed that the delays incident to the carrying out of such comprehensive plans will keep the output within 3,500 tons of metallic lead.

In Chaffee county the Monarch district has been the greatest producer, next to Leadville. The Madonna mines, owned by the Colorado Smelting Company, shipped, in 1885, 32,000 tons gross or 29,000 tons net, yielding about 10,000 tons of lead.

The White Pine district, in Gunnison county, is a lead carbonate camp, with the Eureka Nest Egg as the most prominent mine operated by the American Mining and Smelting Company, which ships the product to the Royal George smelter at Cañon City, owned by the same company. The majority of the other mines are mere prospects, and the ore of several of them carries an undesirable percentage of zinc carbonate. For the grade of its silver ores the district is too far distant from railroad communication, and heavy snowfalls further embarrass shipping. Therefore it is assumed that the shipments will not exceed 20 tons per 250 shipping days, or 1,400 tons of metallic lead for the year.

Until the spring of 1885 Custer county produced very little lead ore, the only mine of any consequence being the Bull Domingo, the ore from which requires concentration. Operations were begun during the course of 1885 to open a known lower ore body, but the plant was destroyed by fire. The only important lead mine is the Terrible, at Ilse, at the head of Oak creek, which, with its concentrating plant, has gone into the hands of the Omaha and Grant Smelting Company. The ore is quarried in a width of about 90 feet, the lead occurring as cerussite disseminated in a porphyry gangue. The mill produces daily two carloads of 60 per cent. concentrates. Allowing only 250 working days, the output would be 5,000 tons of ore, equivalent to 3,000 tons of metal. A few smaller concentrators at Silver Cliff and the Bull Domingo may probably add 200 tons of metallic lead to the output of Custer county for the current year.

Clear Creek, Boulder, Gilpin, Summit, and Park counties have gradually increased their output during the past five years from 1,000 to 1,500 tons of lead, the greatest part of which is the product of concentration. Some of it, from Park and Summit counties, goes to Leadville.

Those irregularly producing districts are to be considered next, whose product cannot reach the great smelting centers at Denver and in the Arkansas valley. Depending as they do, therefore, upon local markets, their output has been pushed. During the last two years attempts have been made at several points in southern and western Colorado to create permanent home markets by the building of smelting works. The majority of these efforts have ended in failure, the points showing greatest vitality being Durango, Rico, and Gunnison

City. The districts tributary to these markets may send there and to competitive points a tonnage equal to 6,000 tons of lead.

Recapitulating these figures; we have the probable lead output of Colorado as follows:

*Probable output of lead in Colorado in* 1886.

| Locality. | Metallic lead in ore. | Locality. | Metallic lead in ore. |
|---|---|---|---|
| Leadville: | *Short tons.* | Printer Boy hill—Continued. | *Short tons.* |
| Main Fryer hill | 370 | Little Ellen hill | 1,200 |
| East Fryer hill | 750 | Mt. Sheridan, Sugar Loaf, St. Kevin | 300 |
| Yankee hill | 300 | | |
| Carbonate hill | 9,200 | Total, Leadville | 32,660 |
| Iron hill: | | Red Cliff, Eagle county | 3,500 |
| Iron Silver Consolidated | 3,840 | Aspen | 3,500 |
| Adlaide, Terrible, Argentine, Humboldt, Newton | 1,000 | Klamath district, Chaffee county | 11,000 |
| Benton | 1,600 | White Pine, Gunnison county | 1,400 |
| Louisville, Colorado No. 2, Ruby. | 2,250 | Custer county, Terrible, &c | 3,200 |
| Smuggler, Iron Hill, Consolidated, Blind Tom, Queen of the West, A. Y. carbonates | 1,200 | Clear Creek, Boulder, Gilpin, Summit, and Park counties | 1,500 |
| Colonel Sellers sulphide | 4,250 | Gunnison, Rico, and Durango smelters and districts | 6,000 |
| Minnie, A. Y. sulphide | 1,000 | | |
| Rock hill: | | Total | 62,760 |
| Sullivan, Only Chance, Emmet | 1,500 | Deduct 15 per cent. for loss in transit of ore, moisture, and loss in smelting | 8,214 |
| La Plata, Crown Point Pinnacle, and others | 2,500 | | |
| Printer Boy hill: | | Total | 54,546 |
| Lillian and others | 1,000 | | |
| Upper Iowa gulch | 400 | | |

The above estimate was submitted for revision to Mr. Bauman in July. He reports that the estimate for Fryer Hill calls for no modification, and that the aggregate for Carbonate Hill will remain the same, although the Adams and Morning Star mines have turned out more than the figure given them. On the other hand, there has been a corresponding falling below the expectations of the Henriett and Maid of Erin, due to troubles with water. It should be noted also that the Castleview is coming in as a fair producer. Mr. Bauman thinks it possible that Carbonate Hill may exceed the estimate of 2,000 tons if the present rate of output is continued. For the first half of the year it has not been attained, however. On Iron hill about 1,000 tons should be deducted from the figure credited to the Benton deposit, but, on the other hand, the Louisville and Colorado No. 2 will make up the deficiency. In the Monarch district, Chaffee county, the Madonna will fall behind somewhat on account of trouble with surface water. The amount lost will, however, be covered by the Silent Friend. The shipments from Red Cliff are larger than given, but the percentage of lead in the ore accepted as the average is too high, so that there will be no material change.

*Montana.*—The Helena Mining and Reduction Company, at Wickes, has continued its prosperous career, having produced during 1885, 3,464 tons of lead, 601,362 ounces of silver, 18,440 dwts. of gold, and 10,433 pounds of copper, which is about the same as the product of 1884. The company paid dividends aggregating $138,500. In southern Montana

the Glendale was the leading producer, though the dividends, $195,000, were not so heavy as those of 1884. At Toston a smelter has been in operation part of the time and has since turned out larger quantities. Some lead was produced also in the Barker district and in Beaver Head county. Better transportation facilities will, it is expected, make the Ten-Mile district, known to carry heavy lead ores, a more prominent section.

*Idaho.*—The year 1885 has witnessed considerable development in the lead and silver mines of Idaho, though in the aggregate its product has not come up to the expectations of an earlier period. It is difficult to arrive at any accurate estimate of the lead product, because a large, in fact the heaviest, proportion is shipped in the form of ores and concentrates. In the Wood River district the Queen of the Hills has been the leading producer, having shipped in 14 months, of which 2½ were lost by a strike, 3,636 tons of ore, estimated to average about 70 per cent. of lead, the freight and smelting charges being reported at $37 per ton. Towards the end of the year the capacity of the concentrating plant has been doubled to 100 tons per day. The Idahoan has also been productive and prosperous, while the output of the Minnie Moore has fallen off through the faulting of the deposit. The Mayflower has been run by tributers, its concentrating works being idle, and the Eureka has done nothing. At Ketchum the smelting works of the Philadelphia Company have been turning out some bullion. The Buzzo mine has done little, the Parker has been prospecting, and the Elkhorn has contributed little to the market. In the Little Wood River district some work was accomplished by the Eagle Bird. From the Galena, Little Smokey, and Sawtooth districts small quantities of high-grade ores have been shipped, and in some cases transportation facilities have been improved, so that there is some outlook for a larger and steadier supply. At Bay Horse the smelter has been idle, while A. J. Cook & Co.'s reduction works at Clayton have turned out about 500 tons of base bullion. At Nicholia, smelting operations have been carried on for a part of the year.

The higher prices for lead are likely to stimulate its production considerably during the current year, and a heavier output from Idaho is confidently expected.

*New Mexico.*—In New Mexico the Billing works at Socorro turned out by far the heaviest proportion of the lead produced in this Territory. According to published returns the make was 4,651 tons of base bullion, carrying 909,652 ounces of silver and 3,926 ounces of gold. Besides this a small quantity of lead in the aggregate has been added to the output by scattered concerns smelting intermittently. The total make of lead from New Mexican ores did not probably reach 5,000 tons.

*Arizona.*—The only two works which produced lead in Arizona were the Benson works, Cochise county, which, according to published returns, made 2,435 tons of base bullion, and the smelter of the Tombstone Mining and Milling company, which added 728 tons, making a

net product of about 3,000 tons. Considerable quantities of ore carrying some lead are shipped to distant smelters. Nogales is the only addition to the reduction plants, and it gets a good deal of ore from Mexico, which comes in free, being argentiferous.

*Missouri.*—Under the stimulus of good prices, the product of the non-argentiferous mines of Missouri, Kansas, and Illinois has gained, and it is likely to grow further still, during the current year. The product of the St. Joe, Desloge, and Mine La Motte companies, the leading ones in Missouri, aggregated alone in 1885, 13,863 short tons. The works of the Desloge company were destroyed by fire, and the property has since been acquired by the St. Joe Lead Company.

### IMPORTS.

Since the shortage in the supply of domestic lead, the imports have again assumed significance. The following tables give in detail the quantities of ore and dross, pigs and bars, sheets, pipe, and shot, and other manufactures not specified, imported since 1867:

*Lead imported and entered for consumption in the United States, 1867 to 1885 inclusive.*

| Fiscal years ending June 30— | Ore and dross. | | Pigs and bars. | | Sheets, pipe, and shot. | | Shot. | | Not otherwise specified. | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | *Pounds.* | | | |
| 1867 | 611 | $25 | 65,322,923 | $2,812,668 | 185,825 | $9,560 | ..... | ..... | $6,222 | $2,828,475 |
| 1868 | 6,945 | 239 | 63,254,677 | 2,668,915 | 142,137 | 7,229 | ..... | ..... | 6,604 | 2,682,987 |
| 1869 | ..... | ..... | 87,865,471 | 3,653,481 | 307,424 | 15,531 | ..... | ..... | 18,885 | 3,687,897 |
| 1870 | 5,973 | 176 | 85,895,724 | 3,530,837 | 141,681 | 6,879 | ..... | ..... | 10,444 | 3,548,336 |
| 1871 | 316 | 10 | 91,496,715 | 3,721,096 | 86,712 | 4,209 | ..... | ..... | 8,730 | 3,734,045 |
| 1872 | 32,331 | 1,425 | 73,086,657 | 2,929,623 | 12,518 | 859 | ..... | ..... | 20,191 | 2,952,098 |
| 1873 | ..... | ..... | 72,423,641 | 3,233,011 | 105 | 12 | 420 | $50 | 21,503 | 3,254,576 |
| 1874 | ..... | ..... | 46,205,154 | 2,231,817 | ..... | ..... | 30,219 | 1,349 | 36,484 | 2,269,650 |
| 1875 | 13,206 | 320 | 32,770,712 | 1,559,017 | ..... | ..... | 58 | 4 | 25,774 | 1,585,115 |
| 1876 | ..... | ..... | 14,329,366 | 682,132 | ..... | ..... | 20,007 | 1,204 | 27,106 | 710,442 |
| 1877 | 1,000 | 20 | 14,583,845 | 671,482 | ..... | ..... | 16,502 | 1,242 | 1,041 | 673,785 |
| 1878 | ..... | ..... | 6,717,052 | 294,233 | ..... | ..... | 15,829 | 963 | 113 | 295,309 |
| 1879 | ..... | ..... | 1,216,500 | 42,983 | ..... | ..... | 3,748 | 209 | 930 | 44,122 |
| 1880 | ..... | ..... | 6,723,706 | 246,015 | ..... | ..... | 1,120 | 54 | 371 | 246,440 |
| 1881 | 5,981 | 97 | 4,322,068 | 189,129 | ..... | ..... | 900 | 65 | 1,443 | 160,734 |
| 1882 | 21,698 | 500 | 6,079,304 | 202,603 | ..... | ..... | 1,469 | 99 | 2,449 | 205,651 |
| 1883 | 600 | 17 | 4,037,867 | 130,108 | ..... | ..... | 1,510 | 79 | 8,030 | 138,234 |
| 1884 | 419 | 13 | 3,072,738 | 85,395 | 15,040 | 630 | ..... | ..... | 1,992 | 88,030 |
| 1885 | 4,218 | 57 | 5,862,474 | 143,103 | 971,951 | 22,217 | ..... | ..... | 1,372 | 166,749 |

*Old and scrap lead imported and entered for consumption in the United States, 1867 to 1885 inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Pounds.* | | | *Pounds.* | |
| 1867 | 1,255,233 | $53,202 | 1877 | 249,645 | $8,383 |
| 1868 | 2,465,575 | 101,586 | 1878 | 106,342 | 3,756 |
| 1869 | 2,983,272 | 123,068 | 1879 | 42,283 | 1,153 |
| 1870 | 3,756,785 | 150,379 | 1880 | 213,063 | 5,262 |
| 1871 | 2,289,688 | 94,467 | 1881 | 123,018 | 2,729 |
| 1872 | 4,257,778 | 171,324 | 1882 | 220,702 | 5,949 |
| 1873 | 3,545,098 | 151,756 | 1883 | 1,094,133 | 31,724 |
| 1874 | 395,516 | 13,897 | 1884 | 160,356 | 4,830 |
| 1875 | 382,150 | 13,964 | 1885 | 4,866 | 106 |
| 1876 | 265,860 | 9,534 | | | |

*Lead ashes imported and entered for consumption in the United States,* 1869 *to* 1881 *inclusive.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1869 | $1,461 | 1875 | $503 |
| 1870 | 8,892 | 1876 | 4,241 |
| 1871 | 8,852 | 1877 | 33,297 |
| 1872 | 1,315 | 1878 | 4,886 |
| 1873 | 254 | 1879 | 69 |
| 1874 | 1,583 | 1881 (*a*) | 67 |

*a* Not separately classified since 1881.

EXPORTS.

Except during the period of 1842 to 1846, both fiscal years included, and in the years 1878 and 1879, when considerable quantities of lead were sent to China, the export movement of lead has always been insignificant as compared with the home production.

*Lead and manufactures of lead, of domestic production, exported from the United States.*

| Fiscal years ending September 30 until 1842, and June 30 since. | Manufactures of— | | | Bars, shot, etc. | | Total value. |
|---|---|---|---|---|---|---|
| | Lead. | | Pewter and lead. | | | |
| | Quantity. | Value. | Value. | Quantity. | Value. | |
| | *Pounds.* | | | *Pounds.* | | |
| 1790 | 13,440 | $810 | | | | $810 |
| 1803 (barrels) | 900 | | | | | |
| 1804 | 19,804 | | | | | |
| 1805 | 8,000 | | | | | |
| 1808 | 40,583 | | | | | |
| 1809 | 126,537 | | | | | |
| 1810 | 172,323 | | | | | |
| 1811 | 65,497 | | | | | |
| 1812 | 74,875 | | | | | |
| 1813 | 276,940 | | | | | |
| 1814 | 43,600 | | | | | |
| 1815 | 40,245 | | | | | |
| 1816 | 35,844 | | | | | |
| 1817 | 111,034 | 9,993 | | | | 9,993 |
| 1818 | 281,168 | 22,493 | | | | 22,493 |
| 1819 | 94,362 | 7,549 | | | | 7,549 |
| 1820 | 25,699 | 1,799 | | | | 1,799 |
| 1821 | 56,192 | 3,512 | | | | 3,512 |
| 1822 | 66,316 | 4,244 | | | | 4,244 |
| 1823 | 51,549 | 3,098 | | | | 3,098 |
| 1824 | 18,604 | 1,356 | | | | 1,356 |
| 1825 | 189,930 | 12,697 | | | | 12,697 |
| 1826 | 47,337 | 3,347 | | | | 3,347 |
| 1827 | 50,160 | 3,761 | | | | 3,761 |
| 1828 | 76,882 | 4,184 | | | | 4,184 |
| 1829 | 179,952 | 8,417 | | | | 8,417 |
| 1830 | 128,417 | 4,831 | | | | 4,831 |
| 1831 | 152,578 | 7,068 | | | | 7,068 |
| 1832 | 72,439 | 4,483 | | | | 4,483 |
| 1833 | 119,407 | 5,685 | | | | 5,685 |
| 1834 | 13,480 | 805 | | | | 805 |
| 1835 | 50,418 | 2,741 | | | | 2,741 |
| 1836 | 34,600 | 2,218 | | | | 2,218 |
| 1837 | 297,488 | 17,015 | | | | 17,015 |
| 1838 | 375,231 | 21,747 | | | | 21,747 |
| 1839 | 81,377 | 6,003 | | | | 6,003 |
| 1840 | 882,620 | 39,687 | | | | 39,687 |
| 1841 | 2,177,164 | 96,748 | | | | 96,748 |
| 1842 | 14,552,357 | 523,428 | | | | 523,428 |
| 1843 (nine months) | 15,366,918 | 492,765 | | | | 492,765 |
| 1844 | 18,420,407 | 595,238 | | | | 595,238 |
| 1845 | 10,188,024 | 342,646 | | | | 342,646 |
| 1846 | 16,823,766 | 614,518 | | | | 614,518 |
| 1847 | 3,326,028 | 124,981 | | | | 124,981 |
| 1848 | 1,994,704 | 84,278 | | | | 84,278 |
| 1849 | 680,249 | 30,198 | | | | 30,198 |

*Lead and manufactures of lead exported, etc.*—Continued.

| Fiscal years ending September 30 until 1842, and June 30 since. | Manufactures of— | | | Bars, shot, etc. | | Total value. |
|---|---|---|---|---|---|---|
| | Lead. | | Pewter and lead. | | | |
| | Quantity. | Value. | Value. | Quantity. | Value. | |
| | *Pounds.* | | | *Pounds.* | | |
| 1850 | 261,123 | $12,797 | | | | $12,797 |
| 1851 | | | $16,426 | 229,448 | $11,744 | 28,200 |
| 1852 | | | 18,469 | 747,930 | 32,725 | 51,194 |
| 1853 | | | 14,064 | 100,778 | 5,540 | 19,604 |
| 1854 | | | 16,478 | 404,247 | 26,874 | 43,352 |
| 1855 | | | 5,233 | 165,533 | 14,298 | 19,531 |
| 1856 | | | 5,628 | 310,029 | 27,512 | 33,140 |
| 1857 | | | 4,818 | 870,544 | 58,624 | 63,442 |
| 1858 | | | 27,327 | 900,607 | 48,119 | 75,446 |
| 1859 | | | 28,782 | 313,988 | 28,575 | 57,357 |
| 1860 | | | 56,081 | 903,468 | 50,446 | 106,527 |
| 1861 | | | 30,534 | 109,023 | 6,241 | 36,775 |
| 1862 | | | 28,832 | 79,231 | 7,334 | 36,166 |
| 1863 | | | 30,609 | 237,239 | 22,634 | 53,243 |
| 1864 | | | 30,411 | 223,752 | 18,718 | 49,129 |
| 1865 | | | 29,271 | 852,895 | 132,666 | 161,937 |
| 1866 | | | 44,483 | 25,278 | 2,323 | 46,806 |
| 1867 | | | 27,559 | 99,158 | 5,300 | 32,859 |
| 1868 | | | 37,111 | 438,040 | 34,218 | 71,329 |
| 1869 | | | 17,249 | | | 17,249 |
| 1870 | | 28,315 | | | | 28,315 |
| 1871 | | 79,880 | | | | 79,880 |
| 1872 | | 48,132 | | | | 48,132 |
| 1873 | | 13,392 | | | | 13,392 |
| 1874 | | 302,044 | | | | 302,044 |
| 1875 | | 429,309 | | | | 429,309 |
| 1876 | | 102,726 | | | | 102,726 |
| 1877 | | 49,835 | | | | 49,835 |
| 1878 | | 314,904 | | | | 314,904 |
| 1879 | | 280,771 | | | | 280,771 |
| 1880 | | 49,899 | | | | 49,899 |
| 1881 | | 39,710 | | | | 39,710 |
| 1882 | | 178,779 | | | | 178,779 |
| 1883 | | 43,108 | | | | 43,108 |
| 1884 | | 135,156 | | | | 135,156 |
| 1885 | | 123,466 | | | | 123,466 |

## REVIEW OF THE LEAD MARKET.

The following table gives the highest and lowest prices monthly for a series of years:

*Highest and lowest prices of lead at New York City, monthly, from* 1870 *to* 1885 *inclusive.*

[Cents per pound.]

| Years. | January. | | February. | | March. | | April. | | May. | | June. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1870 | *a*6.30 | 6.20 | 6.25 | 6.17 | 6.20 | 6.10 | 6.25 | 6.15 | 6.25 | 6.20 | 6.25 | 6.20 |
| 1871 | *a*6.30 | 6.15 | 6.25 | 6.20 | 6.20 | 6.15 | 6.20 | 6.10 | 6.18 | 6.10 | 6.15 | 6.12 |
| 1872 | *a*6.00 | 5.90 | 6.00 | 5.87 | 6.00 | 5.87 | 6.12 | 5.90 | 6.62 | 6.25 | 6.62 | 6.40 |
| 1873 | *a*6.37 | 6.25 | 6.50 | 6.40 | 6.50 | 6.25 | 6.50 | 6.25 | 6.62 | 6.35 | 6.55 | 6.12 |
| 1874 | *a*6.00 | 5.90 | 6.25 | 6.00 | 6.25 | 6.12 | 5.25 | 5.90 | 6.00 | 5.75 | 6.00 | 5.62 |
| 1875 | *a*6.20 | 6.00 | 5.90 | 5.85 | 5.75 | 5.62 | 5.87 | 5.80 | 5.95 | 5.90 | 5.90 | 5.75 |
| 1876 | *a*6.00 | 5.87 | 6.37 | 6.00 | 6.50 | 6.40 | 6.40 | 6.12 | 6.50 | 6.10 | 6.50 | 6.25 |
| 1877 | *b*6.15 | 6.12 | 6.40 | 6.20 | 6.75 | 6.50 | 6.50 | 6.25 | 6.00 | 5.55 | 5.70 | 5.60 |
| 1878 | 4.35 | 4.00 | 3.87 | 3.65 | 3.87 | 3.62 | 3.75 | 3.50 | 3.50 | 3.25 | 3.50 | 3.12 |
| 1879 | 4.50 | 4.00 | 4.50 | 4.50 | 4.50 | 3.25 | 3.25 | 2.87 | 3.12 | 2.87 | 3.80 | 3.12 |
| 1880 | 6.10 | 5.50 | 6.00 | 5.87 | 5.95 | 5.30 | 5.75 | 5.40 | 5.25 | 4.40 | 4.75 | 4.50 |
| 1881 | 5.00 | 4.30 | 5.10 | 4.80 | 4.85 | 4.62 | 4.85 | 4.37 | 4.70 | 4.25 | 4.50 | 4.25 |
| 1882 | 5.15 | 4.95 | 5.20 | 5.00 | 5.12 | 4.85 | 5.00 | 4.90 | 4.85 | 4.60 | 4.90 | 4.55 |
| 1883 | 4.70 | 4.60 | 4.60 | 4.50 | 4.65 | 4.50 | 4.62 | 4.40 | 4.55 | 4.40 | 4.45 | 4.40 |
| 1884 | 4.50 | 3.75 | 4.10 | 3.75 | 4.15 | 4.10 | 4.05 | 3.62½ | 3.75 | 3.52½ | 3.65 | 3.57½ |
| 1885 | 3.70 | 3.55 | 3.70 | 3.60 | 3.70 | 3.62½ | 3.70 | 3.62½ | 3.75 | 3.60 | 3.85 | 3.62½ |

*a* Gold. *b* Currency.

*Highest and lowest prices of lead at New York City, &c.*—Continued.

[Cents per pound.]

| Years. | July. | | August. | | September. | | October. | | November. | | December. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1870 | 6.30 | 6.20 | 6.37 | 6.32 | 6.37 | 6.30 | 6.37 | 6 25 | 6.35 | 6.25 | 6.35 | 6.25 |
| 1871 | 6.15 | 6.10 | 6.12 | 6.00 | 6.10 | 6.00 | 6.00 | 5.87 | 6.00 | 5.90 | 6.00 | 5.75 |
| 1872 | 6.02 | 6.40 | 6.50 | 6.40 | 6.50 | 6.30 | 6 62 | 6.40 | 6.60 | 6.50 | 6.60 | 6.42 |
| 1873 | 6.12 | 6.00 | 6.25 | 6.00 | 6.62 | 6.37 | 6.75 | 6.25 | 6.50 | 6.00 | 6.12 | 6.00 |
| 1874 | 5.80 | 5.62 | 5.80 | 5.65 | 6.10 | 5.65 | 6.35 | 6.10 | 6.50 | 6.25 | 6.40 | 6.12 |
| 1875 | 6.00 | 5.95 | 5.95 | 5.87 | 5.87 | 5.70 | 5.65 | 5.60 | 5.87 | 5.65 | 5.95 | 5.87 |
| 1876 | 6.35 | 6.20 | 6.37 | 6.25 | 6.25 | 6.00 | 6.00 | 5.80 | 5.80 | 5.70 | 5.70 | 5.65 |
| 1877 | 5.60 | 5.37 | 5.12 | 4.90 | 4.85 | 4.75 | 4.85 | 4.25 | 4.75 | 4.50 | 4.60 | 4.50 |
| 1878 | 3.62 | 3.25 | 3.50 | 3.20 | 3.45 | 3.25 | 3.60 | 3.37 | 3.95 | 3.60 | 4.00 | 3.90 |
| 1879 | 4.10 | 3.90 | 4.05 | 4.00 | 4.00 | 3.75 | 5.50 | 4.00 | 5.62 | 5.00 | 5.60 | 5.50 |
| 1880 | 4.75 | 4.25 | 5.00 | 4.30 | 4.90 | 4.80 | 4.87 | 4.65 | 4.85 | 4.75 | 4.75 | 4.25 |
| 1881 | 4.90 | 4.50 | 4.95 | 4.75 | 5.37 | 4.95 | 5 25 | 4.87 | 5.25 | 4.90 | 5.25 | 5.00 |
| 1882 | 5.15 | 4.90 | 5.10 | 4.95 | 5.15 | 4.95 | 5.15 | 4.85 | 4.90 | 4.50 | 4.75 | 4.50 |
| 1883 | 4.40 | 4.30 | 4.30 | 4.20 | 4.32 | 4.30 | 4.32 | 4.12 | 4.05 | 3.65 | 3.75 | 3.60 |
| 1884 | 3.70 | 3.55 | 3.70 | 3.52½ | 3.75 | 3.55 | 3.75 | 3.60 | 3.55 | 3.37½ | 3.75 | 3.50 |
| 1885 | 4.15 | 3.87½ | 4.25 | 4.12 | 4.25 | 4.00 | 4.25 | 4.00 | 4.60 | 4.00 | 4.67½ | 4.50 |

An average of the sales reported in the trade papers during the years 1883, 1884, and 1885, from week to week in the three principal markets, New York, Chicago, and Saint Louis, will yield a fair approximation to the figures at which lead has sold. The sales at Saint Louis and Chicago are of course converted into their equivalent laid down in New York.

*Average market price of lead at New York City.*

| Periods. | Cents per pound. |
|---|---|
| First half, 1883 | 4.51 |
| Second half, 1883 | 4.07 |
| Average, 1883 | 4.28 |
| First half, 1884 | 3.824 |
| Second half, 1884 | 3.632 |
| Average, 1884 | 3.766 |
| First half, 1885 | 3.785 |
| Second half, 1885 | 4.278 |
| Average, 1885 | 4.045 |

These figures, of course, are the average, irrespective of different brands and qualities, and, as they do not include jobbing sales, represent very closely the average result of wholesale transactions. The differences between market prices of the different qualities of lead have become much smaller than they were formerly, and are rarely larger than 5 cents per hundred pounds, or $1 per ton.

*Foreign markets.*—Since the foreign markets have again acquired importance through importations of lead on a larger scale, the fluctuations for a series of years are of interest. The average price of English lead in London from 1860 to 1885 has been as follows:

*Average price of English lead in London from* 1860 *to* 1885.

| Years. | Price per ton. | Years. | Price per ton. |
|---|---|---|---|
| | £ s. d. | | £ s. d. |
| 1860 | 22 6 3 | 1873 | 23 6 0 |
| 1861 | 21 0 4 | 1874 | 22 2 0 |
| 1862 | 20 16 3 | 1875 | 22 9 4 |
| 1863 | 20 16 0 | 1876 | 21 13 0 |
| 1864 | 21 12 0 | 1877 | 20 11 3 |
| 1865 | 20 2 0 | 1878 | 16 14 0 |
| 1866 | 20 10 0 | 1879 | 14 16 6 |
| 1867 | 19 11 0 | 1880 | 16 7 6 |
| 1868 | 19 6 6 | 1881 | 14 19 3 |
| 1869 | 19 11 6 | 1882 | 14 7 3 |
| 1870 | 18 13 0 | 1883 | 12 18 0 |
| 1871 | 18 4 0 | 1884 | 11 16 0 |
| 1872 | 20 0 0 | 1885 | 11 11 0 |

In detail the fluctuations in the London and Paris markets during the year 1885 have been as follows:

*Fluctuations in the price of lead in the London and Paris markets in* 1885.

| Months. | English lead (London), per long ton. | Spanish lead (London), per long ton. | French lead (Paris), per 100 kilos. |
|---|---|---|---|
| | £ s. d. | £ s. d. | *Francs.* |
| January | 11 0 1 | 10 15 0 | 27.50 |
| February | 10 17 6 | 10 10 2 | 27.56 |
| March | 10 15 7 | 10 8 5 | 27.56 |
| April | 10 19 0 | 10 10 4 | 27.56 |
| May | 11 5 6 | 10 17 6 | 28.25 |
| June | 11 10 3 | 11 2 2 | 28.87 |
| July | 12 13 0 | 12 6 0 | 32.20 |
| August | 12 5 0 | 11 14 4 | 30.81 |
| September | 11 11 10 | 11 3 9 | 29.62 |
| October | 11 10 6 | 11 4 6 | 29.30 |
| November | 11 19 8 | 11 14 4 | 30.00 |
| December | 12 12 6 | 12 3 5 | 31.06 |
| Average | 11 11 8½ | 11 4 2 | 29.19 |

1885.—During 1885 the price of lead fluctuated as follows from month to month:

*Price of lead in* 1885.

[Cents per pound.]

| Months. | Highest. | Lowest. |
|---|---|---|
| January | 3.70 | 3.55 |
| February | 3.70 | 3.60 |
| March | 3.70 | 3.62½ |
| April | 3.70 | 3.62½ |
| May | 3.75 | 3.60 |
| June | 3.85 | 3.62½ |
| July | 4.15 | 3.87½ |
| August | 4.25 | 4.12 |
| September | 4.25 | 4.00 |
| October | 4.25 | 4.00 |
| November | 4.60 | 4.00 |
| December | 4.67½ | 4.50 |

The year 1885 was one of considerable uncertainty, and a number of fluctuations were experienced. In the beginning of the year efforts to advance the price fell flat owing to the slackness of the demand, and February proved a very dull month in the eastern markets. The out look for the spring trade in the latter, in March, was not bright, and

consumers there took comparatively little, while in the West corroders were heavy buyers. April was dull, and May only slightly better, but in June a heavier demand, backed by speculation, put up values, which, however, were again unsettled because round blocks of Richmond lead became available. August thus was made a dull month, and it was only in September, when the fall demand set in, that there was more activity. The sale of Richmond lead, however, again affected prices in October. In November speculation again took hold, on the strength of diminished supplies, a gradual exhaustion of stocks, and a generally more cheerful business outlook, carrying lead up to 4.60 cents for large lines. A number of small blocks of foreign lead were bought in for consumption, irrespective of the small quantities usually imported by cartridge makers and canners to be re-exported under the drawback clauses. With the close of the year the market became duller, January delivery being freely offered from the West at 4.60 cents.

The production of lead in the world has been estimated as follows:

*The world's production of lead.*

| Countries. | 1876. | 1881. | 1882. | 1883. | 1884. |
|---|---|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| Spain | 101, 522 | 105, 809 | 115, 368 | 126, 889 | 116, 293 |
| Germany | 77, 500 | 90, 216 | 92, 591 | (*b*)98, 846 | 102, 584 |
| England | 59, 606 | 49, 364 | 51, 133 | 39, 817 | 40, 716 |
| France | (*a*)8, 500 | (*a*)8, 500 | 8, 076 | 7, 827 | (*a*)7, 500 |
| Italy | (*a*)6, 000 | (*a*)13, 000 | (*a*)14, 000 | 14, 320 | (*a*)14, 000 |
| Greece | (*a*)8, 000 | 11, 892 | 6, 645 | 9, 612 | (*a*)8, 000 |
| Belgium | 7, 275 | 7, 651 | 8, 805 | 8, 391 | (*a*)8, 000 |
| Austria | 4, 291 | 8, 782 | 11, 113 | (*b*)11, 134 | (*b*)11, 391 |
| Hungary | (*a*)2, 000 | (*a*)1, 850 | 1, 843 | (*a*)1, 800 | (*a*)1, 800 |
| Russia | 1, 169 | 987 | 573 | (*a*)500 | (*a*)500 |
| Sweden | (*a*)400 | (*a*)400 | 494 | (*a*)500 | (*a*)400 |
| United States | 58, 118 | 106, 208 | 120, 544 | 139, 836 | 126, 907 |
| Mexico | (*a*)1, 000 | (*a*)1, 000 | (*a*)1, 000 | (*a*)1, 000 | (*a*)1, 000 |
| Turkey | (*a*)250 | (*a*)250 | (*a*)500 | *a*750 | (*a*)600 |
| Australia | (*a*)500 | (*a*)500 | (*a*)1, 000 | 5, 054 | (*a*)5, 000 |
| South America | ..... | (*a*)1, 500 | (*a*)1, 500 | (*a*)2, 000 | (*a*)2, 000 |
| Total | 336, 131 | 407, 910 | 435, 185 | 468, 276 | 446, 691 |

*a* Estimated. *b* Including litharge, estimated at 80 per cent. lead.

*Spain.*—Through the kindness of Señor Don Ramon Oriol, editor of the *Revista Minera y Metalurgica*, the official volumes of the mineral statistics have been received covering the years 1881, 1882, and 1883, the latter being the last issued. According to these documents the production of lead ore in the principal provinces for the three years was as follows:

*Production of lead ore in Spain in the years* 1881, 1882, *and* 1883.

| Provinces. | 1881. | 1882. | 1883. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| Murcia | 189, 452 | 189, 380 | 156, 548 |
| Jaen | 113, 186 | 104, 856 | 89, 391 |
| Almeria | 20, 719 | 22, 329 | 16, 888 |
| Badajos | 13, 406 | 18, 541 | 12, 270 |
| Huelva | 2, 815 | 2, 795 | 2, 218 |
| Ciudad Real | 1, 716 | 1, 402 | 1, 465 |
| Total, including less important provinces unenumerated | 342, 938 | 341, 818 | 280, 061 |

The official statistics enumerate separately the quantities of argentiferous lead ore, the principal producing provinces being as follows:

*Production of argentiferous lead ore in Spain in the years* 1881, 1882, *and* 1883.

| Provinces. | 1881. | 1882. | 1883. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| Almeria | 17,731 | 16,306 | 21,506 |
| Guipuzcoa | 2,285 | 1,889 | 1,850 |
| Ciudad Real | 2,086 | 2,330 | 543 |
| Badajos | 2,281 | 1,292 | ..... |
| Total, including provinces not specified | 24,655 | 22,425 | 24,548 |

These ores, of both classes, are worked partly in the same province, and are largely, too, sent to smelting works in other provinces, Murcia doing the bulk of this business. The following table, grouping the lead product by provinces, does not therefore represent the source of the metal, but merely shows the relative importance of the different provinces as smelting centers.

*Production of lead by provinces.*

| Provinces. | 1881. | 1882. | 1883. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| Murcia | 42,798 | 36,426 | 32,688 |
| Almeria | 19,067 | 14,776 | 20,999 |
| Cordova | 10,812 | 17,391 | 25,730 |
| Guipuzcoa | 8,308 | 8,680 | 8,050 |
| Jaen | 4,940 | 4,977 | 5,447 |
| Malaga | 3,731 | 3,340 | 2,550 |
| Ciudad Real | 35 | 1,786 | 2,480 |
| Badajos | 932 | 963 | 1,368 |
| Gerona | 49 | ..... | ..... |
| Total | 90,672 | 88,339 | 99,312 |

These figures differ strikingly from the data furnished by the export returns, the latter being given in the official documents as follows:

*Export of refined lead from Spain.*

| Countries. | 1881. | 1882. | 1883. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| France | 18,084 | 23,266 | 25,139 |
| England | 41,212 | 49,539 | 50,702 |
| Portugal | 120 | 342 | ..... |
| Germany | 371 | 229 | 249 |
| Sweden | 103 | ..... | ..... |
| Russia | 32 | ..... | ..... |
| Cuba | 27 | 12 | 34 |
| United States | 453 | ..... | 220 |
| Ecuador | 2 | 2 | 8 |
| Holland | ..... | 202 | ..... |
| Gibraltar | ..... | 3 | ..... |
| Porto Rico | ..... | 4 | 9 |
| Italy | ..... | ..... | 519 |
| Brazil and New Granada | ..... | ..... | 14 |
| Total | 60,404 | 73,599 | 76,894 |

In addition to this the following quantities of "argentiferous lead," or base bullion, as it is termed in this country, were exported:

*Export of lead (base bullion) from Spain.*

| Countries. | 1881. | 1882. | 1883. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| France | 19,873 | 21,142 | 20,478 |
| England | 29,449 | 20,394 | 31,420 |
| Belgium | 364 | 31 | ..... |
| Portugal | 87 | ..... | ..... |
| Total base bullion | 49,773 | 41,567 | 51,898 |
| Total refined lead | 60,404 | 73,599 | 76,894 |
| Total lead export | 110,177 | 115,166 | 128,792 |

In addition to these figures the export returns give small quantities of manufactures of lead and considerable amounts of "galena," as follows, small quantities not enumerated going to other countries besides those named:

*Export of lead ore from Spain.*

| Countries. | 1881. | 1882. | 1883. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| France | 1,504 | 2,512 | 3,439 |
| England | 1,886 | 2,214 | 2,459 |
| Belgium | 5,793 | 7,725 | 8,464 |
| Total | 9,183 | 12,451 | 14,362 |

Deducting 5 per cent. for waste on the base bullion, allowing for the lead contents of the ore at the rate of 60 per cent., and adding, finally, the exports of manufactured lead, we reach the following approximate estimate of the lead exports from Spain:

*Lead exports from Spain.*

| Years. | Metric tons. |
|---|---|
| 1881 | 113,477 |
| 1882 | 120,849 |
| 1883 | 135,691 |
| 1884 | 116,293 |
| 1885 | 109,014 |

This makes no allowance for domestic consumption. The discrepancy between these figures and the production reported by the mining department is so enormous that the system of collecting the statistics of production must be so exceptionally defective as to be absolutely worthless. The official documents offer no explanation whatever for it. Spanish metallurgical works do not handle any foreign ores or base bullion, nor can it be claimed that the excess of shipments over output returned to the department was from accumulated stocks, because the same large

differences appear year after year. A graphic chart attached to the report for 1883, published last year, exhibits a third set of figures at variance with those published in former reports. This office has, therefore, continued to accept as the only fairly reliable guide for the production of Spain the export figures published, and until explanations are forthcoming must warn those in the lead trade to regard the reports of the Spanish mining department with suspicion.

*Germany.*—The production of Germany, the second in importance in Europe, has been as follows for a series of years:

*Production of lead in Germany.*

| Years. | Quantity. | Years. | Quantity. |
|---|---|---|---|
| | *Metric tons.* | | *Metric tons.* |
| 1852 to 1855 | 15,000 to 20,000 | 1876 | 77,500 |
| 1856 to 1859 | 20,000 to 25,000 | 1877 | 79,970 |
| 1860 | 28,000 | 1878 | 83,336 |
| 1861 and 1862 | 30,000 to 35,000 | 1879 | 85,566 |
| 1863 and 1864 | 35,000 to 40,000 | 1880 | 88,867 |
| 1865 and 1866 | 40,000 to 45,000 | 1881 | 90,216 |
| 1867 | 49,000 | 1882 | 95,860 |
| 1868 to 1872 | 50,000 to 60,000 | 1883 | 94,811 |
| 1873 | 64,000 | 1884 | 98,814 |
| 1874 | 72,030 | 1885 | 92,485 |
| 1875 | 69,900 | | |

The production of the different districts in Germany is shown by the following table, the make of silver being added, since it largely influences the profits of the different works. In the case of Freiberg and the Hartz it probably includes some silver extracted from rich imported Mexican and South American ores:

*Production of lead and silver in Germany.*

| Districts. | Lead. | | | Silver. | | |
|---|---|---|---|---|---|---|
| | 1883. | 1884. | 1885. | 1883. | 1884. | 1885. |
| Prussia: | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Kilos.* | *Kilos.* | *Kilos.* |
| Stolberg Company | 13,753 | 15,983 | 15,956 | 23,989 | 26,770 | 33,127 |
| Rhenish-Nassau Company | 6,457 | 6,177 | 6,170 | 5,953 | 6,062 | 8,027 |
| Mechernich Company | 25,582 | 26,200 | 23,481 | 4,369 | 5,257 | 5,248 |
| Commern Company | 1,640 | ..... | ..... | 525 | ..... | ..... |
| A. Poensgen & Sons | 3,540 | 3,300 | 3,910 | 1,757 | 1,967 | 2,824 |
| Rothenbach Works | 44 | 36 | 56 | 886 | 793 | 903 |
| Walther Cronek Works | 5,154 | 5,403 | 5,428 | 3,397 | 3,071 | 3,268 |
| Friedrichs Works | 9,561 | 11,351 | 12,804 | 5,755 | 6,671 | 6,697 |
| Hanover: | | | | | | |
| Upper Hartz | 9,749 | 9,541 | 8,991 | 37,259 | 42,828 | 39,321 |
| Lower Hartz | 599 | 1,268 | 3,108 | 5,252 | 4,867 | 6,934 |
| Nassau: | | | | | | |
| Ems | 5,227 | 5,641 | 4,608 | 7,418 | 6,585 | 6,460 |
| Braubach | 3,187 | 3,732 | 3,901 | 9,915 | 7,612 | 10,034 |
| Saxony: | | | | | | |
| Freiberg | 5,274 | 5,469 | 4,072 | 58,946 | 60,309 | 79,952 |
| Total | 89,767 | 94,101 | 92,485 | 165,421 | 172,792 | 202,795 |

In addition to the pig lead produced there were marketed in 1883, 5,044 tons of litharge and in 1884, 4,713 tons. Besides there were obtained in several zinc works of Upper Silesia, in 1883, 556 tons of lead

as a by-product, not counted. The corresponding figure for 1884 is not known. The silver product given does not, it may be incidentally mentioned, include the output of the Mansfeld copper works, which, having been 50,985 kilograms in 1882, 58,946 kilograms in 1883, and 60,309 kilograms in 1884, swells the total silver product of Germany to 213,982 kilograms for 1882, 233,884 kilograms for 1883, and 246,925 kilograms for 1884.

The greatest lead mine of the world, and in many respects one of the most remarkable ones, is that of the Mechernich Mining Company. Working a very low-grade sandstone containing small accretions of galena, distributed through it with fair uniformity, the mining operations are carried out on a grand scale, followed by concentration of great magnitude, which in 1885 turned out 33,759 tons of lead ore and 1,078 tons of potters' ore, yielding 23,480 tons of lead and 5,248 kilograms of silver. On a capital of 9,600,000 marks, the company realized a gross profit of 1,650,157.54 marks; or, after writing off 378,854.16 marks, a net profit of 1,271,303.38 marks, out of which a dividend of 12 per cent. per annum was declared. Putting in the mining property at 4,011,806.30 marks, the company showed assets of 12,276,704.47 marks, and carried a reserve fund of 960,000 marks.

*Great Britain.*—The tendency toward a decline in the output of the British mines has been checked during 1884. Owing to the closing down of mines and the voluntary liquidation of mining companies, however, a decline again took place in 1885. The following figures are gathered from the official statistics:

*Lead statistics of Great Britain.*

| Years. | Production of lead ore. | Lead from British ores. | Silver. | Lead imported and obtained from foreign ores. | British and foreign lead exported. | Available for home consumption. |
|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Ounces.* | *Long tons.* | *Long tons.* | *Long tons.* |
| 1874 | 76,801 | 58,777 | 509,277 | 74,351 | 41,321 | 91,807 |
| 1875 | 77,746 | 57,435 | 487,358 | 89,705 | 38,624 | 108,516 |
| 1876 | 79,096 | 58,667 | 483,422 | 91,010 | 42,685 | 106,992 |
| 1877 | 80,850 | 61,403 | 497,375 | 105,472 | 47,885 | 118,990 |
| 1878 | 77,350 | 58,023 | 397,471 | 112,977 | 36,478 | 134,519 |
| 1879 | 66,878 | 41,635 | 333,674 | 117,014 | 40,530 | 128,119 |
| 1880 | 72,245 | 56,949 | 295,518 | 107,211 | 38,344 | 125,816 |
| 1881 | 64,702 | 48,587 | 308,398 | 106,593 | 48,453 | 106,727 |
| 1882 | 65,001 | 50,328 | 372,446 | 100,331 | 40,018 | 110,641 |
| 1883 | 50,980 | 39,190 | 344,053 | 118,521 | 42,848 | 114,863 |
| 1884 | 54,485 | 40,075 | ..... | 132,829 | 37,631 | 135,273 |
| 1885 | 51,302 | 37,687 | ..... | 129,402 | 42,169 | 124,920 |

During the early part of 1885 there was much distress among English lead miners, but the better prices ruling during the second half of the year aided them considerably. The principal sources of the lead and lead ore imported into England are the following, the total imports of pig and sheet lead having been 108,063 long tons, and of lead ore 26,738 long tons:

*Principal imports of lead and lead ore into Great Britain in* 1885.

| Countries. | Lead ore. | Countries. | Lead. |
|---|---|---|---|
| | *Long tons.* | | *Long tons.* |
| Italy | 6,690 | Germany | 9,218 |
| Greece | 2,320 | Holland | 5,822 |
| Turkey | 1,375 | France | 1,585 |
| Algeria | 9,854 | Spain | 76,556 |
| Australasia | 2,804 | Greece | 8,147 |
| | | United States | 4,989 |

The principal exports of British lead, aggregating 23,545 long tons, were as follows:

*Principal exports of British lead in* 1885.

| Countries. | Long tons. |
|---|---|
| Russia | 1,439 |
| France | 812 |
| East Indies | 2,536 |
| China | 3,781 |
| Hong-Kong | 8,213 |
| Australasia | 2,578 |
| British North America | 1,437 |
| United States | 436 |

The principal exports of British pipe and sheet lead were as follows:

*Principal exports of British manufactures of lead in* 1885.

| Countries. | Long tons. |
|---|---|
| Russia | 1,813 |
| Germany | 976 |
| Portugal | 417 |
| East Indies | 2,380 |
| Australasia | 3,120 |
| British North America | 700 |
| Brazil | 636 |

The total, including a number of shipments of smaller amounts to other countries, was 14,981 long tons, to which must be added 2,902 tons of lead and sheet lead of foreign origin.

*Italy.*—The leading mines in Italy are those of G. Henfrey & Co. at Pertusola, on the Gulf of Spezia, near Sargana, the del Bottino works having been closed in 1883 and the Cogoleto works, near Genoa, having been altered for another purpose in the same year. Producing, as they do now, about 15,000 tons of lead and 30,000 kilograms of silver, they have taken a leading rank among the great metallurgical establishments of Europe. The ore supply is derived almost exclusively from Sardinia, the principal mines being those of Montevecchio, Monteponi, Monte Santo, Nebida, and Malacalzetta. Thus an important source of

supply of English and Belgian works is diverted to Italy. The following figures will illustrate the growth of the business done:

*Production of the Pertusola works.*

| Years. | Argentiferous lead ore worked. | Lead produced. | Silver produced. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Kilograms.* |
| 1867 | 3,867 | 2,257 | 1,028 |
| 1868 | 7,044 | 4,642 | 2,457 |
| 1869 | 7,310 | 4,416 | 1,667 |
| 1870 | 6,695 | 3,851 | 1,515 |
| 1871 | 6,994 | 4,250 | 1,815 |
| 1872 | 7,709 | 4,583 | 1,943 |
| 1873 | 8,469 | 5,036 | 2,273 |
| 1874 | 7,679 | 4,401 | 2,413 |
| 1875 | 8,625 | 6,018 | 2,461 |
| 1876 | 8,844 | 4,784 | 2,828 |
| 1877 | 10,995 | 6,179 | 3,864 |
| 1878 | 13,652 | 8,088 | 6,848 |
| 1879 | 12,711 | 8,354 | 6,886 |
| 1880 | 15,806 | 10,425 | 10,434 |
| 1881 | 16,795 | 11,496 | 11,518 |
| 1882 | 19,664 | 12,836 | 12,885 |
| 1883 | 19,221 | 13,120 | 12,937 |

Since 1884 the supply which formerly went to Cogoleto, chiefly high-grade silver ore, has also gone to Pertusola, and the output has risen to 15,000 tons and 30,000 kilograms of silver. The small Sardinian smelting works at Nebida and Masua turn out annually about 1,200 tons of base bullion, which is desilverized at Pertusola, together with some Spanish base bullion.

*Greece.*—The latest statistics available for the production of lead in Greece are those of M. Argyropoulo, of Athens. The bulk of it is the yield from smelting the "ekvolades," or ancient slag piles, to which must be added the lead contents of the Nikias plumbiferous iron ores used as a flux in smelting them. This flux carries from 4 to 6 per cent. of lead. In 1883 the Greek Laurium Company produced 7,693 metric tons of base bullion, carrying 1,600 grams of silver to the metric ton, which is shipped to English desilverizers, while the French Laurium Company turned out 1,919 metric tons, averaging 2,000 grams of silver to the ton, which goes to Marseilles. Besides this the Escombrera Bleyberg Company received 3,880 tons of an ore carrying 30 per cent. of zinc and 10 per cent. of lead with 250 grams of silver.

*Russia.*—The latest official statistics place the product of Russia as follows for a series of years:

*Production of lead in Russia.*

| Years. | Metric tons. |
|---|---|
| 1876 | 1,169 |
| 1877 | 1,205 |
| 1878 | 1,398 |
| 1879 | 1,358 |
| 1880 | 1,147 |
| 1881 | 987 |
| 1882 | 573 |

*Austria.*—In Austria one of the principal lead producers is the Bleiberg Bergwerks Union, which in 1885 turned out 3,812 tons of lead, as compared with 3,975 tons in 1884, on which a profit of 86,802 florins was made, enabling the payment of a dividend of 4½ per cent. The famous mines at Przibram turned out the following quantities for a series of years:

*Product of the Przibram mines.*

| Years. | Soft lead. | Antimonial lead. | Litharge. | Silver. |
|---|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Kilograms.* |
| 1881 | 1,032 | 259 | 2,945 | 30,646 |
| 1882 | 417 | 269 | 3,829 | 30,926 |
| 1883 | 215 | 318 | 3,943 | 32,511 |
| 1884 | 771 | 382 | 3,559 | 34,707 |

Taking litharge at 80 per cent., the 1884 figures represent an output of 4,000 tons.

*France.*—From a study of the French official statistics for the year 1883, the latest available, it appears that taking the yield of the ore extracted from mines in France and Algeria at averaging 70 per cent., the home product is about 3,127 metric tons. In that year there were produced in French smelting works from imported and domestic ores a total of 7,770 metric tons. Besides this, French desilverizers treated 20,956 tons of Spanish and 1,851 tons of Greek base bullion, producing 22,268 tons of refined lead. In that year the consumption of lead in France was officially estimated at 71,000 tons.

# ZINC.

## THE ZINC INDUSTRY OF THE UNITED STATES.

By C. Kirchhoff, Jr.

The conditions affecting the zinc industry during the year 1885 have not materially changed in comparison with former years. The home producers recovered full control of the market, and the formation of a great syndicate abroad proved fully that the low prices then prevailing had become intolerably unremunerative to European makers. It held out the promise that there would be no danger of an influx of foreign spelter, always provided that the restriction of output in Europe was sufficient to keep it within the bounds of current consumption there. American makers have learned to look with alarm at such syndicates, since in the past the latter have believed it good policy to strengthen the European market by sacrificing a small surplus in this country. No indications of such a movement took place in 1885, and it must be admitted that the foreign syndicate was formed too late in the year to allow the necessity for it to develop.

Spelter is consumed in three forms principally. It is used to a moderate extent in this country as sheet zinc, the figures for the production of which are not available since the manufacture is confined to two works; it is used furthermore for galvanizing, a branch depending upon the prosperity of a few branches of the iron trade, and it is used in brass manufacture. The prosperity of the zinc trade may therefore be said to be bound up with activity in building, with a growing demand for sheet iron, barb wire, and a few other specialties in iron manufacture, and with an expansion in the consumption of brass in its many forms. The year 1885 did not witness any revival in building, or in the iron trade, and it may be questioned whether the consumption of spelter in those directions was up to the average. The low price of copper, however, stimulated the introduction of all its forms into new uses, and, as is shown elsewhere in the discussion of the year's history of that metal, a marked increase took place in the quantities manufactured. This has continued, and is the most promising feature connected with the zinc manufacture of the country. It is a fact which has probably averted greater depression, and which must in the future prove the most potent cause towards bringing about a revival. In the spring of 1886 the barb-wire trade proved a keen disappointment, a fact which

of course was reflected in the demand for spelter; but, on the other hand, the unprecedented consumption of iron and steel thus far in 1886 holds out the hope that it will carry with it fuller employment to the spelter works. No effort could be made in 1885 to arrive at data which would show how the consumption of spelter is apportioned among the different industries named, to which should be added, too, the desilverizing of base lead bullion, in which a part of the zinc used for the extraction of the silver is lost during the distillation of the rich zinc crusts, and during the refining of the desilverized lead.

Complete returns have been received from all the spelter-producing works of the United States, with the exception of one small concern in Tennessee, whose output is estimated to have been 300 short tons.

## PRODUCTION.

The records of the production of spelter and zinc in previous years are incomplete, the following figures being the only ones available which are worthy of consideration:

*Production of spelter in the United States.*

| Years. | Short tons. |
|---|---|
| 1873 | 7,343 |
| 1875 | 15,833 |
| 1880 (census year ending May 31) | 23,239 |
| 1882 | 33,765 |
| 1883 | 36,872 |
| 1884 | 38,544 |
| 1885 | 40,688 |

Grouped by States, the product has been as follows:

*Production of spelter in the United States, 1881 to 1885, inclusive, by States.*

| States. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| Illinois | 16,250 | 18,201 | 16,792 | 17,594 | 19,427 |
| Kansas | 5,000 | 7,366 | 9,010 | 7,859 | 8,502 |
| Missouri | 2,750 | 2,500 | 5,730 | 5,230 | 4,677 |
| Eastern and southern States | | 5,698 | 5,340 | 7,861 | 8,082 |
| Total | | 33,765 | 36,872 | 38,544 | 40,688 |

During 1885, the capacity of the zinc works of the United States has not been materially enlarged, and the figures given in former reports from this office may be accepted as correct, with the change that the works of the Missouri Zinc Company, formerly at Carondelet, have been dismantled and should be stricken from the list. The Joplin works in Missouri were idle during eleven months of the year, and the Rich Hill plant, also, did not run up to capacity.

## IMPORTS AND EXPORTS.

*Zinc imported and entered for consumption in the United States, 1867 to 1885 inclusive.*

| Fiscal years ending June 30— | Blocks or pigs. | | Sheets. | | Value of manufactures. | Total value. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | | |
| | *Pounds.* | | *Pounds.* | | | |
| 1867 | 5,752,611 | $256,366 | 5,142,417 | $311,767 | $1,835 | $569,968 |
| 1868 | 9,327,968 | 417,273 | 3,557,448 | 203,883 | 1,623 | 622,779 |
| 1869 | 13,211,575 | 590,332 | 8,306,723 | 478,646 | 2,083 | 1,071,061 |
| 1870 | 9,221,121 | 415,497 | 9,542,687 | 509,860 | 21,696 | 947,053 |
| 1871 | 11,159,040 | 508,355 | 7,646,821 | 409,243 | 26,366 | 943,964 |
| 1872 | 11,802,247 | 522,524 | 10,704,944 | 593,855 | 58,668 | 1,175,077 |
| 1873 | 6,339,897 | 331,399 | 11,122,143 | 715,706 | 56,813 | 1,103,918 |
| 1874 | 3,593,570 | 203,479 | 6,016,835 | 424,504 | 48,304 | 676,287 |
| 1875 | 2,034,252 | 101,766 | 7,320,713 | 444,539 | 26,330 | 572,635 |
| 1876 | 947,322 | 56,082 | 4,611,360 | 298,308 | 18,427 | 372,817 |
| 1877 | 1,266,894 | 63,250 | 1,341,333 | 81,815 | 2,496 | 147,561 |
| 1878 | 1,270,184 | 57,753 | 1,255,620 | 69,381 | 4,892 | 132,026 |
| 1879 | 1,419,791 | 53,294 | 1,111,225 | 53,050 | 3,374 | 109,718 |
| 1880 | 8,092,620 | 371,920 | 4,069,310 | 210,230 | 3,571 | 585,721 |
| 1881 | 2,859,216 | 125,457 | 2,727,324 | 129,158 | 7,603 | 262,218 |
| 1882 | 18,408,391 | 736,964 | 4,413,042 | 207,032 | 4,940 | 948,936 |
| 1883 | 17,067,211 | 655,503 | 3,309,239 | 141,823 | 5,606 | 802,932 |
| 1884 | 5,869,738 | 208,852 | 952,253 | 36,120 | 4,795 | 249,767 |
| 1885 | 3,515,840 | 113,268 | 1,839,860 | 164,781 | 2,054 | 180,103 |

*Exports of zinc and zinc ore of domestic production, 1864 to 1885 inclusive.*

| Fiscal years ending June 30— | Ore or oxide. | | Plates, sheets, pigs, or bars. | | Value of manufactures. | Total value. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | | |
| | *Cwt.* | | *Pounds.* | | | |
| 1864 | 14,810 | $116,431 | 95,738 | $12,269 | ..... | $128,700 |
| 1865 | 99,371 | 114,149 | 184,183 | 22,740 | ..... | 136,889 |
| 1866 | 4,485 | 25,091 | 140,798 | 13,290 | ..... | 38,381 |
| 1867 | 3,676 | 32,041 | 312,227 | 30,587 | ..... | 62,628 |
| 1868 | 8,344 | 74,706 | 1,022,699 | 68,214 | ..... | 142,920 |
| 1869 | ..... | 65,411 | ..... | ..... | ..... | 65,411 |
| 1870 | 15,286 | 81,487 | 110,157 | 10,672 | ..... | 92,159 |
| 1871 | 9,621 | 48,292 | 76,380 | 7,823 | ..... | 56,115 |
| 1872 | 3,686 | 20,880 | 62,919 | 5,726 | ..... | 26,606 |
| 1873 | 234 | 2,304 | 73,953 | 4,656 | ..... | 6,960 |
| 1874 | 2,550 | 20,037 | 43,566 | 3,612 | ..... | 23,649 |
| 1875 | 3,083 | 20,659 | 38,090 | 4,245 | $1,000 | 25,904 |
| 1876 | 10,178 | 66,259 | 134,542 | 11,651 | 4,333 | 82,243 |
| 1877 | 6,428 | 34,468 | 1,419,922 | 115,122 | 1,118 | 150,708 |
| 1878 | 16,050 | 83,831 | 2,545,320 | 216,580 | 567 | 300,978 |
| 1879 | 10,660 | 40,399 | 2,132,949 | 170,654 | ..... | 211,053 |
| 1880 | 13,024 | 42,036 | 1,368,302 | 119,264 | ..... | 161,300 |
| 1881 | 11,390 | 16,405 | 1,491,786 | 132,805 | 168 | 149,378 |
| 1882 | 10,904 | 13,736 | 1,489,552 | 124,638 | ..... | 138,374 |
| 1883 | 3,045 | 11,509 | 852,333 | 70,981 | 734 | 83,224 |
| 1884 | 4,780 | 16,685 | 126,043 | 9,576 | 4,666 | 30,927 |
| 1885 | 6,840 | 22,824 | 101,685 | 7,270 | 4,991 | 35,085 |

PRICES OF ZINC.

The following table summarizes the prices of spelter since 1875:

*Prices of common western spelter in New York City, 1875 to 1885 inclusive.*

[Cents per pound. Figures in parentheses are combination prices.]

| Years. | January. | | February. | | March. | | April. | | May. | | June. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1875 | 6.75 | 6.37 | 6.67 | 6.25 | 6.50 | 6.20 | (7.00) | 6.50 | (7.25) | 7.15 | (7.25) | 7.15 |
| 1876 | (7.60) | 7.40 | (7.75) | 7.50 | (7.75) | 7.62 | (8.00) | 7.60 | (8.00) | 7.75 | (8.00) | 7.25 |
| 1877 | 6.50 | 6.25 | 6.62 | 6.50 | 6.50 | 6.37 | 6.37 | 6.25 | 6.25 | 6.00 | 6.12 | 5.87 |
| 1878 | 5.75 | 5.50 | 5.62 | 5.25 | 5.62 | 5.25 | 5.25 | 5.00 | 5.00 | 4.62 | 4.62 | 4.25 |
| 1879 | 4.50 | 4.25 | 4.62 | 4.40 | 4.62 | 4.37 | 4.75 | 4.25 | 4.50 | 4.25 | 4.37 | 4.12 |
| 1880 | 6.50 | 5.87 | 6.75 | 6.37 | 6.75 | 6.50 | 6.50 | 6.12 | 6.00 | 5.62 | 5.50 | 5.12 |
| 1881 | 5.25 | 4.87 | 5.25 | 5.12 | 5.00 | 4.87 | 5.12 | 4.75 | 5.00 | 4.87 | 5.00 | 4.75 |
| 1882 | 6.00 | 5.75 | 5.75 | 5.62 | 5.62 | 5.37 | 5.50 | 5.25 | 5.62 | 5.25 | 5.37 | 5.25 |
| 1883 | 4.62 | 4.50 | 4.62 | 4.50 | 4.75 | 4.62 | 4.75 | 4.60 | 4.75 | 4.50 | 4.62 | 4.37 |
| 1884 | 4.37 | 4.20 | 4.40 | 4.25 | 4.60 | 4.40 | 4.65 | 4.50 | 4.60 | 4.45 | 4.60 | 4.45 |
| 1885 | 4.50 | 4.12 | 4.30 | 4.25 | 4.30 | 4.12 | 4.30 | 4.12 | 4.25 | 4.10 | 4.10 | 4.00 |

| Years. | July. | | August. | | September. | | October. | | November. | | December. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| 1875 | (7.35) | 7.25 | (7.25) | 7.10 | (7.25) | 7.10 | (7.40) | 7.15 | (7.40) | 7.15 | (7.40) | 7.15 |
| 1876 | 7.25 | 7.12 | 7.25 | 7.00 | 7.12 | 6.80 | 6.75 | 6.62 | 6.62 | 6.37 | 6.50 | 6.37 |
| 1877 | 5.87 | 5.62 | 5.90 | 5.80 | 5.87 | 5.75 | 5.90 | 5.70 | 5.87 | 5.62 | 5.75 | 5.50 |
| 1878 | 4.75 | 4.50 | 4.87 | 4.50 | 4.87 | 4.75 | 4.82 | 4.50 | 4.75 | 4.50 | 4.37 | 4.25 |
| 1879 | 4.75 | 4.37 | 5.62 | 4.80 | 6.00 | 5.62 | 6.37 | 6.00 | 6.25 | 5.87 | 6.25 | 6.00 |
| 1880 | 5.00 | 4.87 | 5.25 | 4.87 | 5.12 | 4.75 | 5.00 | 4.87 | 4.90 | 4.65 | 4.75 | 4.65 |
| 1881 | 5.00 | 4.75 | 5.12 | 5.00 | 5.25 | 5.00 | 5.37 | 5.25 | 5.87 | 5.50 | 6.00 | 5.87 |
| 1882 | 5.37 | 5.12 | 5.50 | 5.12 | 5.37 | 5.12 | 5.37 | 5.12 | 5.12 | 4.87 | 4.87 | 4.50 |
| 1883 | 4.50 | 4.30 | 4.40 | 4.30 | 4.50 | 4.40 | 4.45 | 4.35 | 4.40 | 4.37 | 4.37 | 4.35 |
| 1884 | 4.55 | 4.45 | 4.62 | 4.52 | 4.62 | 4.50 | 4.55 | 4.40 | 4.40 | 4.30 | 4.25 | 4.00 |
| 1885 | 4.40 | 4.10 | 4.60 | 4.40 | 4.62 | 4.50 | 4.62 | 4.50 | 4.60 | 4.45 | 4.60 | 4.45 |

**1885.**—During 1885 the price of spelter fluctuated as follows:

*Price of spelter in 1885.*

[Cents per pound.]

| Months. | Highest. | Lowest. | Months. | Highest. | Lowest. |
|---|---|---|---|---|---|
| January | 4.50 | 4.12 | July | 4.40 | 4.10 |
| February | 4.30 | 4.25 | August | 4.60 | 4.40 |
| March | 4.30 | 4.12 | September | 4.62½ | 4.50 |
| April | 4.30 | 4.12 | October | 4.62½ | 4.50 |
| May | 4.25 | 4.10 | November | 4.60 | 4.45 |
| June | 4.10 | 4.00 | December | 4.60 | 4.45 |

During the year 1885 the spelter market was generally quiet, with a declining tendency during the first half of the year, recovering in July to higher figures which were fairly well maintained during the balance of the year, a slight weakness developing towards its close. The event of the year was the formation in Europe of a spelter combination in

which all of the Silesian, Belgian, Rhenish, French, and English works finally joined, representing an annual output of 250,000 tons. The principal point in connection with the pool is the agreement to restrict the output to the quantities made during 1884, beginning with 1886 and continuing till the middle of 1889. The only exception is Silesia, which is allowed to make 5 per cent. more than was produced in 1884. All the works may increase at a rate to be fixed in the future when the price of zinc goes beyond a given figure. It is understood that the penalty for exceeding the allotment is £13 per ton of excess.

### THE PRINCIPAL FOREIGN PRODUCERS.

*Total production.*—Although the bulk of the spelter now imported into the United States is re-exported under drawback clauses, the foreign markets have an influence which must not be underrated upon the course of the metal in this country. Mr. Archibald Means, of Peru, Illinois, in an argument before the Committee on Ways and Means of the House of Representatives, has given some figures relating to wages and value of ores in the United States, comparing them with the data relating to Silesia, compiled from official sources in the report from this office for 1883 and 1884. Mr. Means gives as follows the wages paid in 1885 by the Illinois Zinc Company:

*Wages paid by Illinois Zinc Company in* 1885.

| Class of labor. | Average hours. | Wages per day. | Class of labor. | Average hours. | Wages per day. |
|---|---|---|---|---|---|
| Labor on the furnaces: | | | Labor in sheet-zinc mill: | | |
| 62 men | 12 | $1.90 | 9 rollers | 8 | $3.00 |
| 40 men | 12 | 1.45 | 18 rollers | 8 | 1.80 |
| 76 men | 8 | 1.45 | 24 men | 10 | 1.35 |
| 22 men | 10 | 1.20 | 10 men | 10 | 1.60 |
| 4 men | 10 | 2.25 | 26 boys | 10 | .85 |
| 9 boys | 10 | .85 | | | |

The comparison of the cost of ores stands as follows:

*Cost of ore in Silesia and in Missouri and Kansas.*

| Years. | Average value per ton. | |
|---|---|---|
| | Silesia. | Missouri and Kansas. |
| 1879 | $3.32 | $13.20 |
| 1880 | 3.44 | 17.20 |
| 1881 | 2.27 | 14.50 |
| 1882 | 2.53 | 17.20 |
| 1883 | 1.90 | 20.00 |

It should be noted in this connection, however, that the Silesian ores are generally leaner than those of our western mines.

The production of spelter in the world in 1881, 1882, 1883, and 1884 was as follows, compiled from the best sources available:

*The world's production of spelter.*

| Countries. | 1881. | 1882. | 1883. | 1884. |
|---|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| Germany | 105,272 | 115,346 | 116,688 | 125,182 |
| Belgium | 69,800 | 72,947 | 75,366 | 77,487 |
| France | (a)18,500 | 18,525 | 15,915 | (a)16,500 |
| England (b) | 24,810 | 25,990 | 28,104 | 29,727 |
| Spain | 4,910 | 4,973 | 4,233 | (a)4,200 |
| Austria | 4,119 | 4,791 | 4,539 | 4,536 |
| Hungary | (a)600 | 605 | (a)600 | (a)600 |
| Russia | 4,552 | 4,472 | 3,789 | 4,227 |
| United States | 27,450 | 30,628 | 33,459 | 34,975 |
| Total | 260,013 | 278,277 | 282,693 | 297,434 |

*a* Estimated. *b* Estimated by Henry Merton & Co., London.

Messrs. Henry Merton & Co., of London, grouping the figures somewhat differently, make the world's production as follows:

*Merton's estimate of the world's production.*

| Countries. | 1885. | 1884. | 1883. | 1882. | 1881. | 1880. |
|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Rhine district and Belgium | 129,754 | 130,522 | 123,891 | 119,193 | 110,989 | 98,830 |
| Silesia | 79,623 | 76,116 | 70,405 | 68,811 | 66,497 | 64,459 |
| Great Britain | 23,099 | 29,259 | 28,661 | 25,581 | 24,419 | (a)22,000 |
| France and Spain | 14,847 | 15,341 | 14,671 | 18,075 | (a)18,358 | 15,000 |
| Poland | 5,019 | 4,164 | 3,733 | 4,400 | (a)4,000 | (a)4,000 |
| Austria | 2,928 | 2,365 | 2,867 | 3,199 | (a)2,520 | (a)2,520 |
| Total, Europe | 255,270 | 257,767 | 244,228 | 239,259 | 226,783 | 206,809 |
| Total, United States | 36,339 | 34,414 | 32,921 | 30,148 | (a)27,000 | 20,749 |
| Grand total | 291,609 | 292,181 | 277,149 | 269,407 | 253,783 | 227,558 |

(a) Estimated.

The differences between the two tables arise from the fact that Messrs. Merton & Co. include in the product of Belgium that part of the make of the Vieille Montagne Company, which is turned out at the works located in France.

*Germany.*—The production of spelter in Germany is shown by the following table, giving the output of the three great districts, Silesia, the Rhenish provinces, and Westphalia:

*Production of spelter in Germany.*

| Years. | Silesia. | Rhenish provinces. | Westphalia. | Total. |
|---|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| 1878 | 59,710 | 19,887 | 15,631 | 95,228 |
| 1879 | 63,413 | 18,942 | 14,066 | 96,421 |
| 1880 | 65,798 | 19,606 | 14,362 | 99,766 |
| 1881 | 67,474 | 21,034 | 16,764 | 105,272 |
| 1882 | 69,992 | 24,654 | 20,700 | 115,346 |
| 1883 | 71,468 | 24,471 | 20,749 | 116,688 |
| 1884 | 77,247 | 48,029 | | 125,276 |
| 1885 (approximate) | 79,623 | (a)37,321 | | (a)118,001 |

*a* Exclusive of scattering works.

The total production of ore in Prussia in 1882, 1883, and 1884 was as follows:

*Production of zinc ore in Prussia.*

| Years. | Calamine. | Blende. | Total. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| 1882 | 480,615 | 212,754 | 693,369 |
| 1883 | 457,979 | 218,817 | 676,796 |
| 1884 | 387,624 | 243,611 | 631,235 |

In detail the product of the different districts was in 1884:

*Production of zinc ore by districts in* 1884.

| Districts. | Calamine. | Blende. | Total. |
|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| Silesia | 371,973 | 143,384 | 515,357 |
| Hanover | ... | 5,480 | 5,480 |
| Westphalia | 12,688 | 26,472 | 39,160 |
| Hesse-Nassau | ... | 13,634 | 13,634 |
| Rhine provinces | 2,963 | 54,641 | 57,604 |
| Total | 387,624 | 243,611 | 631,235 |

The supply of calamine is falling off and the works are becoming more and more dependent upon blende.

As indicating the better returns on capital, the result of the operation of the leading zinc company in Silesia may be quoted. The Schlesiche Actien-Gesellschaft für Bergbau- und Zinkhüttenbetrieb, which made a profit of 1,716,742 marks in 1883, yielded 2,783,666 marks in 1885, on a product of 22,080 metric tons of spelter, and 4,612 tons of sulphuric acid produced from 91,399 tons of calamine, 39,469 tons of blende, and 2,565 tons of zinc products. They use the spelter made in the manufacture of sheet zinc, of which the company turned out 27,748 tons in 1885.

The Actien-Gesellschaft für Bergbau, Blei- und Hütten-fabrikation zu Stolberg und in Westfalien made a profit in 1885 of 775,887 marks, against 678,024 marks in 1884, and only 452,440 marks in 1883, enabling the payment of six per cent. on preferred and one per cent. on common shares. The product of the concern has remained about the same; in 1885 it was 14,673 tons of spelter, 15,956 tons of lead and 33,127 kilograms of silver. The Rheinisch-Nassauische Bergwerk und Hütten Actien-Gesellschaft made a profit of 241,914 marks, or 3 per cent., on the sale of 6,656 tons of argentiferous lead ore and 17,395 tons of zinc ore.

Of these two companies, the former may be accepted as a representative of the Silesian district and the latter of the Rhine provinces. The Stolberg Company, however, as will be noted, produces lead and silver, and for that reason its financial results are not so directly a proof of the condition of its spelter industry.

The product of the works of the Rhine provinces is often grouped

with those of Belgium, with which they naturally form one group. Messrs. Merton & Co. give the output of the different works as follows:

*Production of the Rhine district and Belgium.*

| Name of company. | 1885. | 1884. | 1883. | 1882. | 1881. | 1880. |
|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Vieille Montagne | 50,687 | 52,532 | 49,265 | 48,140 | 49,600 | 44,690 |
| Stolberg Company | 14,452 | 14,283 | 14,496 | 14,921 | 12,601 | 11,643 |
| Austro-Belge | 9,610 | 9,270 | 8,986 | 8,695 | 8,455 | 8,406 |
| Rhein-Nassau Company | 7,676 | 7,827 | 7,623 | 6,458 | 5,760 | 5,669 |
| L. de Laminne | 7,039 | 6,596 | 6,257 | 6,163 | 5,814 | 5,490 |
| Nouvelle Montagne | 5,079 | 5,030 | 5,392 | 5,800 | 5,400 | 5,158 |
| Märk, Westf., Bergw., Ver. | 4,429 | 5,270 | 5,095 | 5,784 | 6,300 | 4,876 |
| G. Dumont & Frères | 7,072 | 5,800 | 5,800 | 5,500 | 5,500 | 4,200 |
| Gladbach Company | 5,046 | 5,000 | 4,800 | 4,916 | 4,861 | 4,613 |
| Escombrera Bleyberg | 5,835 | 5,579 | 5,136 | 4,577 | 2,998 | 1,200 |
| Eschger Ghesquière & Co | 3,792 | 3,970 | 4,600 | 4,170 | 3,700 | 2,885 |
| Grillo | 5,158 | 5,400 | 4,078 | 2,569 | ..... | ..... |
| Société Prayon | 3,879 | 3,965 | 2,363 | (*a*)1,500 | ..... | ..... |
| Total | 129,754 | 130,522 | 123,891 | 119,193 | 110,989 | 98,830 |

Messrs. Merton & Co., have compiled the following table to show the make of the different works in Silesia.

*Production of Silesia.*

| Name of company. | 1885. | 1884. | 1883. | 1882. | 1881. | 1880. |
|---|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Schlesische Actien-Gesellschaft | 21,750 | 21,609 | 20,495 | 20,494 | 18,300 | 17,158 |
| G. von Giesche's Erben | 16,782 | 16,716 | 15,418 | 14,941 | 14,986 | 13,351 |
| Herzog von Ujest | 14,937 | 10,949 | 10,233 | 9,956 | 8,853 | 6,994 |
| Graf H. Henckel von Donnersmarck | 9,680 | 10,040 | 10,238 | 9,129 | 8,593 | 9,135 |
| Graefin Schaffgotsch | 6,091 | 6,204 | 6,348 | 6,327 | 6,600 | 6,305 |
| Graf G. Henckel von Donnersmarck | 1,682 | 1,502 | 1,415 | 1,463 | 1,392 | 1,349 |
| H. Roth | 1,733 | 1,036 | 913 | 938 | 846 | 760 |
| W. Martulik | ..... | 418 | 479 | 353 | 537 | 590 |
| Wünsch | 1,808 | 1,330 | 1,083 | 1,122 | 1,006 | 1,175 |
| Von Tiele-Winckler | ..... | 2,625 | 1,100 | 1,035 | 1,721 | 2,011 |
| Vereinigte Königs & Laurahütte | 1,305 | 1,180 | 1,018 | 1,011 | 1,026 | 1,094 |
| Graf Ballestrem | 658 | 842 | 730 | 874 | 588 | 680 |
| Saeftel | 876 | 780 | 480 | 645 | 625 | 690 |
| G. v. Kramsta'sche Erben | ..... | ..... | ..... | ..... | 550 | 1,361 |
| A. Wolff | ..... | 430 | 430 | 458 | 474 | 1,028 |
| Oberschlesische Bk. für H. & J | ..... | ..... | ..... | ..... | 280 | 393 |
| Fiscus | 106 | 145 | 25 | 65 | 90 | 80 |
| Weidemann | ..... | ..... | ..... | ..... | 30 | 305 |
| Schmieder (Lazy) | 2,165 | 310 | ..... | ..... | ..... | ..... |
| Total | 79,623 | 76,116 | 70,405 | 68,811 | 66,497 | 64,459 |

(*a*) Estimated.

The imports of spelter and sheet zinc into Germany in 1884, and in the first eleven months of 1885, were as follows:

*Imports of spelter into Germany.*

| Source. | 1884. | Eleven months, 1885. |
|---|---|---|
| | *Metric tons.* | *Metric tons.* |
| Hamburg-Altona | 475 | 355 |
| Austria-Hungary | 987 | 729 |
| France | 215 | 8 |
| Belgium | 1,186 | 1,090 |
| Great Britain | 1,526 | 654 |
| Other countries | 131 | 670 |
| Total | 4,520 | 3,506 |

The exports of spelter and sheet zinc from Germany are, of course, very heavy. The following table gives the latest data available:

*Exports of spelter and sheet zinc from Germany.*

| Destination. | Spelter. | | Sheet zinc. | |
|---|---|---|---|---|
| | 1884. | Eleven months, 1885. | 1884. | Eleven months, 1885. |
| | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| Hamburg-Altona | 23,067 | 15,600 | 5,122 | 3,442 |
| Denmark | ..... | 50 | 610 | 704 |
| Norway | ..... | 72 | 363 | 436 |
| Sweden | ..... | 330 | 509 | 518 |
| Russia | 3,109 | 2,390 | ..... | 98 |
| Austria-Hungary | 12,713 | 12,869 | 771 | 1,050 |
| Switzerland | ..... | 136 | 609 | 450 |
| France | 1,251 | 1,713 | ..... | 64 |
| Belgium | 1,238 | 1,521 | 170 | 63 |
| Netherlands | 7,023 | 5,840 | 1,212 | 916 |
| Great Britain | 6,574 | 19,531 | 5,356 | 5,723 |
| Italy | ..... | 215 | 482 | 589 |
| United States | 891 | 1,065 | 579 | 271 |
| Other countries | 1,126 | 248 | 500 | 181 |
| Total | 56,992 | 61,590 | 16,283 | 14,506 |

It will be observed that apparently there has been a large increase in the exports of spelter to Great Britain, while the shipments via Hamburg have fallen off. It is impossible to ascertain, in the absence of the export statistics of Hamburg, whether or not this is due simply to possible changes in the shipping ports, or the transfer of a large part of the business from Silesian to Rhenish works.

*Belgium.*—M. Em. Harzé, in his official report, gives the following data concerning the production of the Belgian mines and the output of the Belgian zinc works:

*Production of the Belgian mines and zinc works.*

| Years. | Blende. | Calamine. | Spelter. | Sheet zinc. |
|---|---|---|---|---|
| | *Metric tons.* | *Metric tons.* | *Metric tons.* | *Metric tons.* |
| 1870 | 15,783 | 41,316 | 45,754 | ..... |
| 1871 | 19,970 | 41,159 | 45,623 | ..... |
| 1872 | 20,623 | 34,914 | 41,838 | .. |
| 1873 | 13,952 | 28,630 | 42,314 | .... |
| 1874 | 17,087 | 26,212 | 46,088 | 20,953 |
| 1875 | 18,750 | 23,754 | 49,960 | 23,176 |
| 1876 | 21,739 | 15,974 | 47,981 | 21,388 |
| 1877 | 26,310 | 18,677 | 55,923 | 23,389 |
| 1878 | 27,134 | 18,159 | 61,227 | 23,178 |
| 1879 | 23,229 | 19,460 | 57,157 | 25,710 |
| 1880 | 23,080 | 15,735 | 59,880 | 22,410 |
| 1881 | 8,169 | 15,384 | 69,800 | 25,304 |
| 1882 | 2,171 | 18,272 | 72,947 | 27,278 |
| 1883 | 3,711 | 16,924 | 75,366 | 27,457 |
| 1884 | 27,606 | | 77,487 | ... |

Taken over a series of years the supplies from home mines, it will be noticed, have declined heavily in the face of a constant increase of the

production of metal. In 1884 the working of a deposit previously flooded added to the output. M. Harzé gives the following details in his report for 1882, 1883, and 1884:

*Statistics of Belgian zinc works.*

| Details. | 1882. | 1883. | 1884. |
|---|---|---|---|
| Works in operation | 11 | 11 | 11 |
| Number of furnaces running | 319 | 327 | 314 |
| Number of furnaces idle | 48 | 60 | 66 |
| Average number of retorts running | 22,299 | 22,521 | 23,313 |
| Number of workmen | 2,864 | 3,507 | 3,649 |
| Average daily wages, francs | 3.41 | 3.38 | 3.25 |
| Ore consumed: | | | |
| Belgian, metric tons | 12,989 | 19,250 | 24,171 |
| Foreign, metric tons | 161,632 | 171,538 | 169,587 |
| Spelter produced, metric tons | 92,947 | 75,366 | 77,487 |

The Vieille Montagne Company, the leading concern in Belgium, used, during its fiscal year 1885, 61,000 tons of ore, of which the bulk was foreign, chiefly Swedish produce. They turned out 51,540 metric tons of spelter, of which 38,675 tons were used for making sheet zinc. In addition thereto they made 6,970 tons of zinc white. The total profit for the year was 2,273,140 francs.

*Great Britain.*—The official statistics of the Mining Record Office do not cover the output of the metallurgical works of the country, and it is only recently that, through the efforts of Messrs. Henry Merton & Co., of London, exact data of the make have become available. The following is the statement of the product of the different works:

*Production of Great Britain.*

| | 1885. | 1884. | 1883. | 1882. | 1881. |
|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| Vivian & Sons | 8,048 | 7,590 | 7,220 | 6,644 | 6,522 |
| English Crown Spelter Company, Limited | 3,500 | 4,570 | 5,200 | 4,792 | 5,062 |
| Dillwyn & Company | 2,967 | 4,894 | 4,060 | 4,800 | 4,400 |
| Swansea Vale Spelter Company | 2,185 | 2,219 | 2,266 | 2,180 | 2,213 |
| Villiers Spelter Company | 1,985 | 2,000 | 2,000 | 2,000 | 1,655 |
| Pascoe, Grenfell & Sons | 1,082 | 1,272 | 1,555 | 1,815 | 1,500 |
| Nenthead & Tynedale Company | 1,380 | 1,384 | 1,556 | 1,500 | 1,350 |
| Kenrick & Sons | | | | 600 | 1,220 |
| D. Swan & Company | | 780 | 1,004 | 550 | 398 |
| Anchor Spelter Company | | 350 | (*a*)700 | (*a*)700 | 99 |
| John Lysaght, Limited | 1,952 | 2,700 | 1,500 | | |
| Staffordshire Knot | | 1,500 | (*a*)1,000 | | |
| Total | 23,099 | 29,259 | 28,661 | 25,581 | 24,419 |

(*a*) Estimated.

The following table summarizes the official statistics of the production of zinc ore from the mines of Great Britain:

*Production of zinc ore in Great Britain.*

| Years. | Zinc ore (blende). | Zinc in ore. | Years. | Zinc ore (b e). | Zinc in ore. |
|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | | *Long tons.* | *Long tons.* |
| 1870 | 13,563 | 3,936 | 1878 | 25,438 | 6,309 |
| 1871 | 17,736 | 4,966 | 1879 | 22,200 | 5,554 |
| 1872 | 18,543 | 5,191 | 1880 | 27,548 | 7,162 |
| 1873 | 15,969 | 4,471 | 1881 | 35,527 | 14,947 |
| 1874 | 16,830 | 4,470 | 1882 | 32 539 | 16,130 |
| 1875 | 23,978 | 6,713 | 1883 | 29,728 | 13,603 |
| 1876 | 23,613 | 6,641 | 1884 | | 9,918 |
| 1877 | 24,406 | 6,833 | | | |

Being by far the largest consumer, Great Britain imports heavy quantities of spelter from the continent. The following are the official figures:

*Imports of zinc into Great Britain.*

| Years. | Crude zinc. | Zinc manufactures. | Years. | Crude zinc. | Zinc manufactures. |
|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | | *Long tons.* | *Long tons.* |
| 1860 | 24,416 | | 1879 | 34,180 | 15,474 |
| 1865 | 32,191 | | 1880 | 33,409 | 16,648 |
| 1870 | 31,103 | | 1881 | 46,198 | 19,302 |
| 1875 | 37,870 | | 1882 | 42,201 | 18,185 |
| 1876 | 29,466 | 14,719 | 1883 | 40,792 | 20,370 |
| 1877 | 35,094 | 16,102 | 1884 | 47,647 | 20,138 |
| 1878 | 32,750 | 16,207 | 1885 | 60,229 | 19,668 |

According to the Board of Trade returns the total imports of zinc ore in 1885 were 21,453 long tons, as against 45,835 tons in 1883. The principal sources of the supply were: Greece, 13,173 tons; Italy, 3,841 tons; Spain, 1,554 tons, and France, 1,085 tons.

The total imports of spelter were 60,129 long tons, of which Germany shipped 31,434 tons, Holland, in transit from Germany and Belgium, 13,790 tons, Belgium direct, 12,598 tons, and France, 1,787 tons.

The imports of manufactures of zinc aggregated 19,664 long tons, of which Germany is credited with 7,189 tons, Holland with 8,369 tons, and Belgium with 3,919 tons.

The total exports of spelter from Great Britain footed up to 7,688 long tons of British spelter and 4,473 long tons of foreign zinc, a total of 12,161 long tons. Of this quantity the East Indies received 5,279 tons of British and 1,794 tons of foreign spelter; Holland, 1,089 tons of the former and 62 tons of the latter, and France, 86 tons of the former and 779 tons of the latter.

*France.*—The largest works are those of the Société Royale Asturienne at Auby-lez-Douai (Nord), which produced in 1884, 11,210 metric tons, against 10,597 metric tons in 1883, chiefly from Spanish ores. The same company has works in Spain.

*Greece.*—Greece is one of the sources of supply of ore for continental and English zinc works. According to the figures of M. Argyropoulo, of Athens, the latest available, there were exported from Greece in 1883 2,601 tons of crude calamine from the Antiparos mine, carrying 35 per cent. of metal, and 37,520 tons of calcined 60 per cent. calamine from the mines of the French Laurium Company, the bulk of which is taken by the Vieille Montagńe Company.

*Russia.*—According to official statistics issued in 1884, the production of spelter in Russia has been as follows for a series of years:

*Production of spelter in Russia.*

| Years. | Metric tons. |
|---|---|
| 1876 | 4,626 |
| 1877 | 4,635 |
| 1878 | 3,646 |
| 1879 | 4,321 |
| 1880 | 4,390 |
| 1881 | 4,552 |
| 1882 | 4,472 |
| 1883 (*a*) | 3,789 |
| 1884 (*a*) | 4,227 |

*a* Estimated.

The figures for 1883 and 1884 are unofficial estimates. According to official returns, gathered for the first time in 1882, the output of ore was 97,000 metric tons.

# QUICKSILVER.

*Present condition of the industry.*—The depression ruling in the quicksilver market in 1884 continued with little change during 1885. There was somewhat less variation in price, and a slight average advance caused a steadier feeling, which, however, being due to increased exports from England to China, was only felt indirectly in the American market.

At one time there were thirty working mines in California; now there are only ten. It is not known that any of these earned a dividend last year, but it is quite certain that none was paid. There was a slight increase in the total production and a noteworthy increase in exports, leaving the market bare of accumulated stock during the greater part of the year. The most encouraging outlook for the coming year is the opening of a number of small gold and silver mines, which will increase the local consumption of quicksilver.

*Domestic sources.*—All the quicksilver produced in the United States comes from mines in California. More than two-thirds of the total supply is from the New Almaden mine; the others are small and sustained with difficulty, particularly since the opposition to Chinese labor, used in all except the New Almaden. The earnings from this mine for the last fifteen years, under the management of Mr. J. B. Randol, are given below:

*Statement of earnings and expenses of the Quicksilver Mining Company, New Almaden, California, from January 1, 1871, to December 31, 1885.*

EARNINGS.

| | | |
|---|---|---|
| Quicksilver produced, 299,822 flasks, average value $35.1204 | | $10,529,851.70 |
| Miscellaneous | | 599,521.20 |
| | | 11,129,372.90 |

EXPENSES.

| | | |
|---|---|---|
| Pay rolls | $4,747,932.67 | |
| Miscellaneous and taxes | 678,687.38 | |
| Materials consumed in operations of mine and furnaces | 1,513,017.21 | |
| | | 6,939,637.26 |
| Profit balance | | 4,189,735.64 |

This profit balance is accounted for as follows:

There have been expended for improvements and repairs $885,354.25, as below. (Since 1872 all repairs have been included in current expenses.)

| | | |
|---|---|---|
| Furnaces and condensers | $299,499.96 | |
| Hoisting works, machinery, pumps, and shafts | 442,681.37 | |
| Houses, sheds, and shops | 74,162.31 | |
| Flumes, water works, ore-cleaning floors, roads, and other surface improvements | 69,010.61 | |
| | | $885,354.25 |

| | | |
|---|---|---|
| Add real estate purchased | 14,500.00 | |
| Add legal expenses and patents | 38,469.62 | |
| Add "black" debt of 1870 | 9,342.68 | |
| | | 62,312.30 |
| Profits expended in California | | 947,666.55 |
| Accounted for by increase in personal property accounts in California and consignments abroad | | 147,523.72 |
| Total profits accounted for in California | | 1,095,190.27 |
| Profits remitted to New York office | | 3,094,545.37 |
| Total profits accounted for | | 4,189,735.64 |
| Funded debt and dividends paid in New York, as per annexed statement | | 2,434,442.80 |
| Interest on funded debt, taxes, legal expenses, etc | | 660,102.57 |
| Profits sent to New York, as above | | 3,094,545.37 |

The company now has neither funded nor floating debt.

*Principal of funded debt and dividends paid in New York.*

| | | |
|---|---|---|
| First mortgage gold bonds (paid June 1, 1873, interest 7 per cent.) | $500,000.00 | |
| Second mortgage gold bonds (paid July 1, 1879, interest 7 per cent.) | 1,000,000.00 | |
| | | $1,500,000.00 |
| DIVIDENDS. | | |
| $9.25 on 42,913 preferred shares, $2.25 on 57,037 common shares, August 4, 1881 | 525,391.00 | |
| $6 on preferred stock, 40 cents on common stock, May 3, 1882 | 280,312.80 | |
| $3 on preferred stock, February 26, 1884 | 128,739.00 | |
| | | 934,442.80 |
| | | 2,434,442.80 |

*Production.*—During 1885, 32,073 flasks, of 76½ pounds net each, were produced, an increase of 160 flasks over the production of 1884, but less than the output of any other year in the last decade. The following table, compiled by Mr. J. B. Randol, gives the entire production of quicksilver in the United States:

*Production of quicksilver in the United States to the close of* 1885, *all from California except* 50 *flasks produced in Oregon in* 1882.

| Years. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Pope Valley. | Napa Consolidated. (*a*) | St. John. | Altoona. | Oceanic. | Oakland. | California. | Great Eastern. | Sunderland. | Cloverdale. | Abbott. | Manhattan. | Various mines. (*b*) | Total yearly production of California mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Flasks.* | *Flasks.* | *Flasks.* | *Flasks.* | *Flasks.* | *Flasks.* | *Flasks.* | *Flasks.* | *Fl'ks.* | *Flasks.* | *Fl'ks.* | *Fl'ks.* | *Fl'ks.* | *Fl'ks.* | *Fl'ks.* | *Fl'ks.* | *Fl'ks.* | *Flasks.* | *Flasks.* | *Flasks.* |
| 1850 | 7,723 | Production from 1858 to 1866, 17,455 flasks—no yearly details obtainable—included in production of various mines. | ..... | ..... | Yearly production previous to 1875 not obtainable (estimated at 20,000 flasks), included in production of various mines. | ..... | ..... | ..... | ..... | Some was produced prior to 1875, but no record kept (estimated production previous to 1875, 1,000 flasks), included in production of various mines. | ..... | ..... | ..... | ..... | ..... | ..... | ..... | Yearly production previous to 1876 not obtainable (estimated at 3,594 flasks), included in production of various mines. | ..... | 7,723 |
| 1851 | 27,779 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | ..... | 27,779 |
| 1852 | 15,901 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 4,099 | 20,000 |
| 1853 | 22,284 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | ..... | 22,284 |
| 1854 | 30,004 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | ..... | 30,004 |
| 1855 | 29,142 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 3,858 | 33,000 |
| 1856 | 27,138 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 2,862 | 30,000 |
| 1857 | 28,204 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | ..... | 28,204 |
| 1858 | 25,761 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 5,239 | 31,000 |
| 1859 | 1,294 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 11,706 | 13,000 |
| 1860 | 7,061 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 2,939 | 10,000 |
| 1861 | 34,429 | | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 571 | 35,000 |
| 1862 | 39,671 | 444 | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 1,885 | 42,000 |
| 1863 | 32,803 | 852 | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 6,876 | 40,531 |
| 1864 | 42,489 | 1,914 | ..... | ..... | | ..... | 800 | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 2,286 | 47,489 |
| 1865 | 47,194 | 3,545 | ..... | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 2,261 | 53,000 |
| 1866 | 35,150 | 6,525 | 2,254 | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 2,621 | 46,550 |
| 1867 | 24,461 | 11,493 | 7,862 | ..... | | ..... | ..... | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 3,184 | 47,000 |
| 1868 | 25,628 | 12,180 | 8,686 | ..... | | ..... | 1,122 | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 112 | 47,728 |
| 1869 | 16,898 | 10,315 | 5,018 | ..... | | ..... | 1,580 | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | ..... | 33,811 |
| 1870 | 14,423 | 9,888 | 4,546 | ..... | | ..... | 1,220 | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | ..... | 30,077 |
| 1871 | 18,568 | 8,180 | 2,128 | ..... | | ..... | 1,970 | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 840 | 31,686 |
| 1872 | 18,574 | 8,171 | 3,046 | ..... | | ..... | 1,890 | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | ..... | 31,621 |
| 1873 | 11,042 | 7,735 | 3,294 | ..... | | 340 | 1,955 | ..... | ..... | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | 3,276 | 27,642 |
| 1874 | 9,084 | 6,911 | 6,678 | 573 | | 1,122 | 1,645 | ..... | 1,743 | | ..... | ..... | ..... | ..... | ..... | ..... | ..... | | ..... | 27,756 |
| 1875 | 13,648 | 8,432 | 7,513 | 5,372 | 3,342 | 3,384 | 1,940 | ..... | 1,927 | 533 | ..... | ..... | ..... | 412 | ..... | ..... | ..... | | 3,747 | 50,250 |
| 1876 | 20,549 | 7,272 | 9,183 | 8,367 | 7,381 | 4,322 | 300 | 573 | 1,683 | 1,979 | 2,358 | 2,150 | 965 | 387 | 1,570 | 1,028 | 1,436 | 976 | 2,595 | 75,074 |
| 1877 | 23,996 | 6,316 | 9,399 | 10,993 | 6,241 | 5,856 | 1,060 | 2,229 | 1,463 | 1,317 | 2,575 | 1,395 | 1,516 | 505 | 735 | 1,291 | 836 | 439 | 1,234 | 79,396 |
| 1878 | 15,852 | 5,138 | 6,686 | 9,465 | 9,072 | 4,963 | 1,075 | 3,049 | ..... | 1,534 | 1,679 | 1,615 | 1,640 | 1,366 | 472 | 116 | ..... | ..... | 158 | 63,880 |
| 1879 | 20,514 | 4,425 | 4,516 | 9,249 | 15,540 | 6,333 | 1,325 | 3,605 | 1,290 | 1,919 | 779 | 1,505 | 1,110 | 1,455 | ..... | 18 | ..... | ..... | 101 | 73,684 |
| 1880 | 23,465 | 3,209 | 2,139 | 10,706 | 6,670 | 6,442 | 275 | 4,416 | 492 | 245 | ..... | 166 | 422 | 1,279 | ..... | ..... | ..... | ..... | ..... | 59,926 |
| 1881 | 26,060 | 2,775 | 2,194 | 11,152 | 5,228 | 6,241 | ..... | 5,552 | ..... | ..... | ..... | ..... | ..... | 1,065 | ..... | 208 | ..... | ..... | 376 | 60,851 |
| 1882 | 28,070 | 1,953 | 2,171 | 5,014 | 1,138 | 5,179 | ..... | 6,842 | ..... | ..... | ..... | ..... | ..... | 2,124 | ..... | ..... | ..... | ..... | 241 | 52,732 |
| 1883 | 29,000 | 1,606 | 1,894 | 2,612 | 84 | 3,869 | ..... | 5,890 | ..... | ..... | ..... | ..... | ..... | 1,669 | ..... | ..... | ..... | ..... | 101 | 46,725 |
| 1884 | 20,000 | 1,025 | 881 | 890 | 1,179 | 3,292 | ..... | 4,307 | ..... | ..... | ..... | ..... | ..... | 332 | ..... | ..... | ..... | ..... | 7 | 31,913 |
| 1885 | 21,400 | 1,144 | 385 | 1,296 | 35 | 3,469 | ..... | 3,506 | ..... | ..... | ..... | ..... | ..... | 446 | ..... | ..... | ..... | ..... | 392 | 32,073 |
| Total | 835,259 | 124,693 | 97,228 | 75,689 | 55,910 | 54,812 | 18,097 | 39,969 | 8,598 | 7,527 | 7,391 | 6,831 | 5,653 | 11,040 | 2,777 | 2,661 | 2,272 | 1,415 | 63,567 | 1,421,389 |

*a* Including Ætna. *b* The column of "various mines" includes the product of the Buckeye, Mt. Jackson, Bacon, Bella Union, American, Porter, Wall Street, Rattlesnake, Kentuck, and other mines. This column includes, in 1882, 50 flasks produced in Oregon.

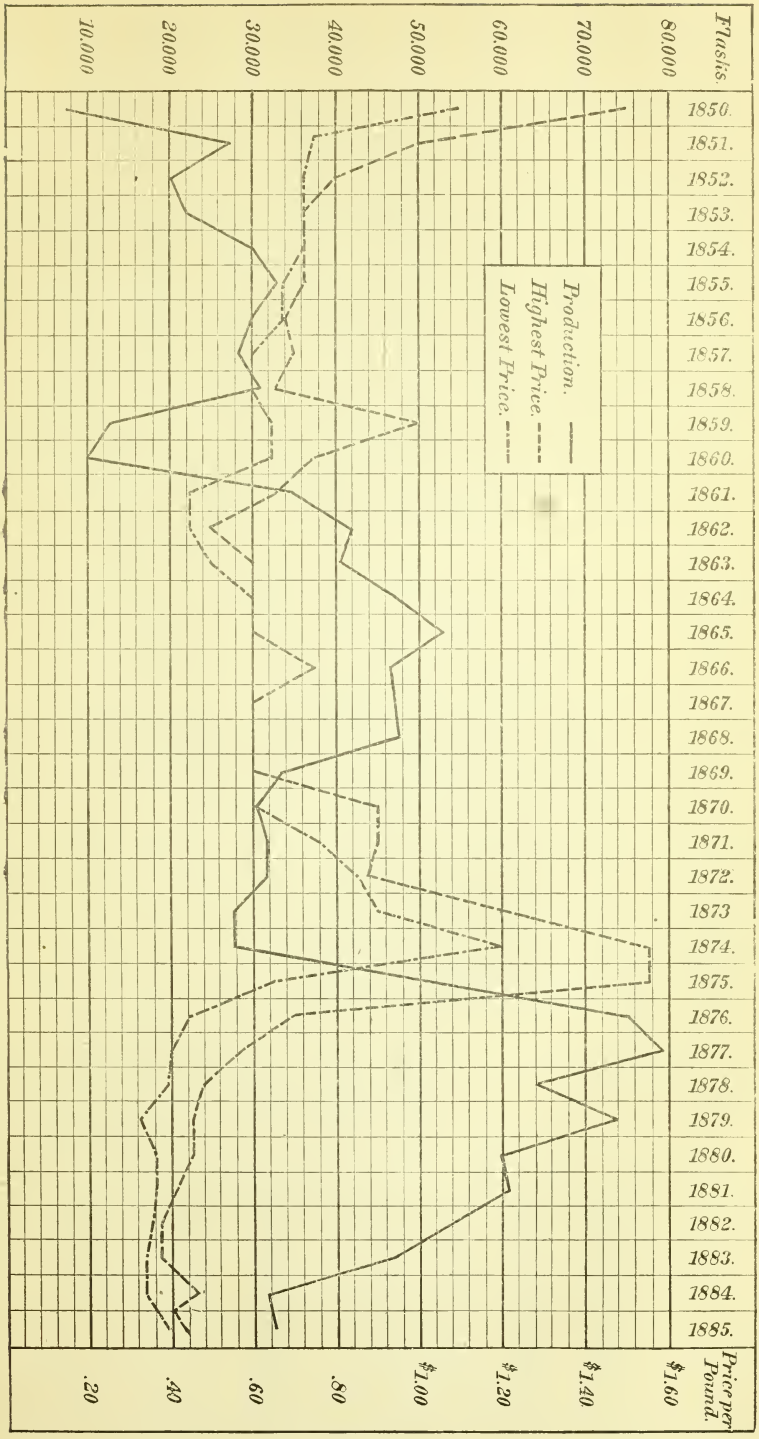


FIG. 6.—Production and price of quicksilver in the United States to December 31, 1885.

*Production of quicksilver in California in* 1883, *by months.*

| Months. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Napa. (*a*) | Great Eastern. | Various. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Flasks.* | *Flasks.* | *Flasks.* | *Flasks.* | *Fl'ks.* | *Flasks.* | *Flasks.* | *Flasks.* | *Fl'ks.* | *Flasks.* |
| January | 2,497 | 112 | 367 | 280 | 77 | 390 | 590 | 262 | 7 | 4,582 |
| February | 2,150 | 133 | 181 | 310 | 7 | 364 | 295 | 156 | 4 | 3,600 |
| March | 2,230 | 142 | 202 | 335 | ..... | 305 | 485 | 162 | 14 | 3,875 |
| April | 1,756 | 76 | 243 | 310 | ..... | 294 | 530 | 142 | 3 | 3,354 |
| May | 2,344 | 144 | 135 | 350 | ..... | 293 | 325 | 164 | 13 | 3,768 |
| June | 2,214 | 137 | 165 | 91 | ..... | 400 | 360 | 184 | 10 | 3,561 |
| July | 2,618 | 85 | 141 | 130 | ..... | 446 | 452 | 150 | 2 | 4,024 |
| August | 3,000 | 139 | 94 | 112 | ..... | 315 | 695 | 76 | ..... | 4,431 |
| September | 3,010 | 164 | 45 | 265 | ..... | 297 | 750 | 81 | 30 | 4,642 |
| October | 2,672 | 272 | 109 | 206 | ..... | 215 | 521 | 134 | ..... | 4,129 |
| November | 2,212 | 115 | 78 | 160 | ..... | 208 | 613 | 102 | ..... | 3,488 |
| December | 2,297 | 87 | 134 | 63 | ..... | 342 | 274 | 56 | 18 | 3,271 |
| Total | 29,000 | 1,606 | 1,894 | 2,612 | 84 | 3,869 | 5,890 | 1,669 | 101 | 46,725 |

*a* Production of Ætna and Napa mines in 1883 under heading of Napa mine.

*Production of quicksilver in California in* 1884, *by months.*

| Months. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. | Napa Con. | Great Eastern. | Various. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Flasks.* | *Flasks.* | *Fl'ks.* | *Fl'ks.* | *Flasks.* | *Flasks.* | *Fl'ks.* | *Fl'ks.* | *Fl'ks.* | *Fl'ks.* | *Flasks.* |
| January | 1,440 | 103 | 127 | 263 | ..... | 373 | 329 | 135 | 28 | 7 | 2,805 |
| February | 1,458 | 59 | 104 | ..... | ..... | 241 | 276 | 174 | 9 | ..... | 2,321 |
| March | 1,606 | 36 | 123 | 68 | ..... | 223 | 249 | 152 | 2 | ..... | 2,459 |
| April | 1,785 | 75 | 50 | 76 | ..... | 232 | 422 | 69 | .... | ..... | 2,709 |
| May | 1,672 | 125 | 53 | 200 | ..... | 169 | 245 | 6 | ..... | ..... | 2,470 |
| June | 1,859 | 44 | 118 | ..... | 200 | 258 | 215 | ..... | ..... | ..... | 2,694 |
| July | 1,543 | 29 | 71 | 52 | 200 | 258 | 374 | 101 | ..... | ..... | 2,628 |
| August | 1,804 | 63 | 47 | 20 | 306 | 334 | 228 | 110 | ..... | ..... | 2,912 |
| September | 1,448 | 67 | 52 | 35 | 58 | 354 | 136 | 169 | 58 | ..... | 2,377 |
| October | 1,625 | 115 | 68 | 25 | 160 | 328 | 153 | 90 | 104 | ..... | 2,668 |
| November | 1,900 | 157 | 32 | 53 | 150 | 230 | 132 | 240 | 91 | ..... | 2,985 |
| December | 1,860 | 152 | 36 | 98 | 105 | 292 | 172 | 130 | 40 | ..... | 2,885 |
| Total | 20,000 | 1,025 | 881 | 890 | 1,179 | 3,292 | 2,931 | 1,376 | 332 | 7 | 31,913 |

*Production of quicksilver in California in* 1885, *by months.*

| Months. | New Almaden. | Ætna. | Napa Con. | Great Western. | Guadalupe. | New Idria. | Sulphur Bank. | Redington. | Great Eastern. | Various. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Flasks.* | *Flasks.* | *Flasks.* | *Flasks.* | *Fl'ks.* | *Flasks.* | *Flasks.* | *Fl'ks.* | *Fl'ks.* | *Fl'ks.* | *Flasks.* |
| January | 1,700 | 189 | 131 | 172 | ..... | 190 | 24 | 40 | 37 | ..... | 2,483 |
| February | 1,506 | 96 | 180 | 245 | 35 | 70 | 85 | 24 | 75 | ..... | 2,316 |
| March | 1,500 | 88 | 145 | 314 | ..... | 80 | 83 | ..... | 33 | 19 | 2,262 |
| April | 2,003 | 142 | 145 | 340 | ..... | 80 | 69 | ..... | 37 | .... | 2,816 |
| May | 2,000 | 62 | 190 | 269 | ..... | 75 | 194 | ..... | ..... | 3 | 2,793 |
| June | 1,750 | 112 | 250 | 330 | ..... | 62 | 91 | 50 | 63 | 5 | 2,713 |
| July | 1,750 | 45 | 191 | 321 | ..... | 75 | 209 | 43 | 50 | 10 | 2,694 |
| August | 2,104 | 118 | 175 | 324 | ..... | 80 | 150 | 49 | ..... | 47 | 3,047 |
| September | 1,936 | 201 | 180 | 347 | ..... | 95 | 85 | 57 | ..... | 77 | 2,978 |
| October | 1,598 | 52 | 185 | 236 | ..... | 85 | 123 | 42 | 65 | 82 | 2,468 |
| November | 1,576 | 54 | 190 | 292 | ..... | 122 | 61 | 43 | 43 | 87 | 2,468 |
| December | 1,977 | 150 | 235 | 279 | ..... | 130 | 122 | 37 | 43 | 62 | 3,035 |
| Total | 21,400 | 1,309 | 2,197 | 3,469 | 35 | 1,144 | 1,296 | 385 | 446 | 392 | 32.073 |

*Prices.*—The extreme range between the highest and lowest prices of quicksilver was not so great as in 1884. The highest price was $33 per flask, at the opening of the year; this was due to the effort of producers to maintain the sudden rise which took place late in 1884; the sales were small, however, until the price was reduced to $29. The rise to $32 at the close of the year was the effect of foreign advances. In London the price was maintained at £6 15*s.* for the first three months of 1885, but only with the result of checking the demand so that the price sank to £6 at the end of March, and gradually declined to £5 10*s.* in May. In August the shipment of about 10,000 flasks to China was followed by an advance to £6 2*s.* 6*d.* Minor fluctuation between this price and £5 17*s.* 6*d.* continued towards the close of the year, when the unsettled political situation in Spain was the most probable cause of a rise to £6 5*s.* It is not probable that this price will be maintained in 1886. At the average price of quicksilver, $30.53 per flask, the value of the total product in 1885 was $979,188, an increase of $42,861 over 1884.

The following table shows the fluctuations in prices for each month during the past three years:

*Monthly quotations of quicksilver at San Francisco in* 1883, 1884, *and* 1885, *per flask.*

| Months. | 1883. | | 1884. | | 1885. | |
|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| January | $26.75 | $26.00 | $26.25 | $26.00 | $33.00 | $32.50 |
| February | 27.25 | 26.00 | 29.00 | 26.00 | 32.50 | 32.50 |
| March | 28.00 | 26.75 | 29.00 | 28.00 | 32.50 | 31.00 |
| April | 27.00 | 26.75 | 29.00 | 28.00 | 31.00 | 30.00 |
| May | 27.00 | 26.75 | 29.00 | 29.00 | 29.00 | 28.50 |
| June | 28.50 | 26.75 | 29.00 | 29.00 | 30.00 | 29.00 |
| July | 28.50 | 27.50 | 29.00 | 28.75 | 30.00 | 29.75 |
| August | 27.50 | 26.25 | 30.00 | 28.75 | 29.75 | 29.50 |
| September | 26.75 | 26.25 | 31.00 | 30.00 | 30.50 | 29.50 |
| October | 26.50 | 26.50 | 30.50 | 29.00 | 30.50 | 30.00 |
| November | 26.50 | 26.00 | 34.00 | 29.00 | 30.00 | 29.75 |
| December | 26.25 | 26.00 | 35.00 | 32.00 | 32.00 | 30.00 |
| Extreme range | 28.50 | 26.00 | 35.00 | 26.00 | 33.00 | 28.50 |
| Average | $26.83 | | $29.34 | | $30.53 | |

The following table shows the extreme range in price per flask of quicksilver in California and in England:

*Highest and lowest prices of quicksilver during the past thirty-six years.*

| Years. | Price in San Francisco, per flask. | | Price in London, per flask. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | | | Lowest. | | |
| | | | £ | s. | d. | £ | s. | d. |
| 1850 | $114.75 | $84.15 | 15 | 0 | 0 | 13 | 2 | 6 |
| 1851 | 76.50 | 57.35 | 13 | 15 | 0 | 12 | 5 | 0 |
| 1852 | 61.20 | 55.45 | 11 | 10 | 0 | 9 | 7 | 6 |
| 1853 | 55.45 | 55.45 | 8 | 15 | 0 | 8 | 2 | 6 |
| 1854 | 55.45 | 55.45 | 7 | 15 | 0 | 7 | 5 | 0 |
| 1855 | 55.45 | 51.65 | 6 | 17 | 6 | 6 | 10 | 0 |
| 1856 | 51.65 | 51.65 | 6 | 10 | 0 | 6 | 10 | 0 |
| 1857 | 53.55 | 45.90 | 6 | 10 | 0 | 6 | 10 | 0 |
| 1858 | 49.75 | 45.90 | 7 | 10 | 0 | 7 | 5 | 0 |
| 1859 | 76.50 | 49.75 | 7 | 5 | 0 | 7 | 0 | 0 |
| 1860 | 57.35 | 49.75 | 7 | 0 | 0 | 7 | 0 | 0 |
| 1861 | 49.75 | 34.45 | 7 | 0 | 0 | 7 | 0 | 0 |
| 1862 | 38.25 | 34.45 | 7 | 0 | 0 | 7 | 0 | 0 |
| 1863 | 45.90 | 38.25 | 7 | 0 | 0 | 7 | 0 | 0 |
| 1864 | 45.90 | 45.90 | 9 | 0 | 0 | 7 | 10 | 0 |
| 1865 | 45.90 | 45.90 | 8 | 0 | 0 | 7 | 17 | 6 |
| 1866 | 57.35 | 45.90 | 8 | 0 | 0 | 6 | 17 | 6 |
| 1867 | 45.90 | 45.90 | 7 | 0 | 0 | 6 | 16 | 0 |
| 1868 | 45.90 | 45.90 | 6 | 17 | 0 | 6 | 16 | 0 |
| 1869 | 45.90 | 45.90 | 6 | 17 | 0 | 6 | 16 | 0 |
| 1870 | 68.85 | 45.90 | 10 | 0 | 0 | 6 | 16 | 0 |
| 1871 | 68.85 | 57.35 | 12 | 0 | 0 | 9 | 0 | 0 |
| 1872 | 66.95 | 65.00 | 13 | 0 | 0 | 10 | 0 | 0 |
| 1873 | 91.80 | 68.85 | 20 | 0 | 0 | 12 | 10 | 0 |
| 1874 | 118.55 | 91.80 | 26 | 0 | 0 | 19 | 0 | 0 |
| 1875 | 118.55 | 49.75 | 24 | 0 | 0 | 9 | 17 | 6 |
| 1876 | 53.55 | 34.45 | 12 | 0 | 0 | 7 | 17 | 6 |
| 1877 | 44.00 | 30.60 | 9 | 10 | 0 | 7 | 2 | 6 |
| 1878 | 35.95 | 29.85 | 7 | 5 | 0 | 6 | 7 | 6 |
| 1879 | 34.45 | 25.25 | 8 | 15 | 0 | 5 | 17 | 6 |
| 1880 | 34.45 | 27.55 | 7 | 15 | 0 | 6 | 7 | 6 |
| 1881 | 31.75 | 27.90 | 7 | 0 | 0 | 6 | 2 | 6 |
| 1882 | 29.10 | 27.35 | 6 | 5 | 0 | 5 | 15 | 0 |
| 1883 | 28.50 | 26.00 | 5 | 17 | 6 | 5 | 5 | 0 |
| 1884 | 35.00 | 26.00 | 6 | 15 | 0 | 5 | 2 | 6 |
| 1885 | 33.00 | 28.50 | 6 | 15 | 0 | 5 | 10 | 0 |
| Extreme range in thirty-six years | 118.55 | 25.25 | 26 | 0 | 0 | 5 | 2 | 6 |

*Foreign sources.*—The most important mines in the world are those in Spain, particularly at Almaden, of which the following is a description taken from the "Iron & Mining Statistics of Spain" for 1883:

The results obtained at the mining establishment of Almaden, Spain, during the year 1883, were as follows:

Five hundred and fifty-six excavations were made in ore and eighty-six in barren ground, the quantities excavated being represented by 5,965.038 and 687.551 cubic meters respectively. The work in ore cost 296,056.86 pesetas (19.3 cents) for labor and 12,774.94 pesetas for the supply and replacement of tools, having taken 73,925 days' labor, which averaged 4 pesetas. Each place produced on an average 10.728 cubic meters, requiring 133 days' labor, and giving a labor cost of 49.63 pesetas per cubic meter and 0.081 cubic meter excavated per day's labor.

The excavations in barren ground cost 26,872.76 pesetas for labor, and 1,642.28 pesetas for the supply and replacement of tools, yielding on an average 7.995 cubic meters each, with 115 days' labor at the rate of 2.73 pesetas, giving as a result 39.08 pesetas per cubic meter and 0.07 cubic meter excavated for every day's labor.

Of the reserves there were excavated at the Pozo mine 529.537 cubic meters and at the Castillo mine 642.569, making a total of 1,172.106 cubic meters.

In the quarries which are worked to obtain material to be used for masonry of all kinds, 6,568.031 cubic meters were excavated in 16 places, showing 3,033½ days' labor, at a cost of 16,277.87 pesetas. There have been excavated besides in one place or cut (tajo) 949.975 cubic meters of clearing, as work preparatory to taking out stone for the masonry, which has cost 1,662.46 pesetas and occupied 304 days' labor.

In the work of underground strengthening of the mine, 620.178 cubic meters of arch and 2,923.711 of solid wall were constructed, costing for labor 5,402.26 and 21,358.07 pesetas, respectively, or say 8.71 pesetas per cubic meter of arch and 7.30 for the wall, and for materials and underground transportation 26.10 and 9.58 pesetas. On the surface the work cost 7,646.33 pesetas for labor and 953.76 for material. The total expense of every kind for masonry work at the establishment amounted to 90,214.38 pesetas.

The total expense of every kind for timbering and carpenter work in the mine amounted to 122,671.82 pesetas, of which 94,488.82 was for labor for timbering.

The hoisting engine at San Teodoro hoisted 21,014 casks of water, equal to the same number of cubic meters, and at the San Miguel 4,579 casks, or 3,754.78 cubic meters, the cost of this work being 1,929.27 pesetas. Extracted from the mine during the year 1883: 159,771.42 metric quintals of ore, 17,243.18 of barren rock, and 6,879.93 of tools for repairs. Sent down into the mine: 6,965.55 metric quintals of tools, 20,353.32 of mortar, 9,646.31 of brick, 885.98 of powder and fuse, and 31,882.99 of stone. The expenses of hoisting and sending down amounted to 24,066.52 pesetas, or 0.09 pesetas per metric quintal.

The expenses at the workshops for work not done by contract was 24,106.61 pesetas, of which 4,523.15 was for blacksmithing, 3,445.52 for carpenter work, 16,002.94 for repairs, and 135 for forges and bellows.

The various sums which have been spent under the name of "expenses for prospecting" have amounted during the year to 110,908.51 pesetas. The unfortunate accidents which occurred at the works of the establishment resulted in 1 death, 4 serious and 102 slight wounds. During the season the 10 pairs of Aludel furnaces and the pair of Idria chamber furnaces (hornos de camara de Idria), which are in the "Circo de Buitrones" were in operation for the reduction of ores, the former having treated 134,136.57 metric quintals of ore, yielding 13,492.177 of quicksilver, and the latter 21,619.95 metric quintals, producing 1,822.407 of quicksilver, the Bustamente furnaces having consumed 4,939 quintals of brushwood, 3,870.08 metrical quintals of wood and 6,447.82 of mineral coal, and the Idria furnaces 3,359 loads of brush The two reverberatory furnaces of rectangular form have also been in operation this year, built for the reduction of fragments in the place

occupied by those called San Firmiro and San Franciscan, and they treated 9,768.51 metric quintals of ore, yielding 460.441 of quicksilver, and consumed 1,467.87 of wood and 968.87 of mineral coal.

In the Canal furnaces 2,343.75 metric quintals of ore were treated, producing 147.653 of quicksilver, and consuming 72.56 quintals of wood and 156.56 of mineral coal. The reduction operations during the year, the ore work and product obtained, are specified in the following tables:

*Table of ores received and worked in the "Circo de Buitrones."*

| | Useless, thrown on dump. | Superior. | Medium. | Poor rock. | Fragments (vaciscos). | Total. |
|---|---|---|---|---|---|---|
| | *Met. quint.* | *Met. quint.* | *Met. quint.* | *Met. quint.* | *Met. quint.* | *Met. quint.* |
| Ores on hand at end of last year | ..... | 10,952.96 | 67,119.06 | 8,278.73 | 118,089.89 | 204,440.64 |
| Ores taken out this year | 3,777.15 | 32,565.78 | 74,432.00 | 18,124.46 | 30,341.48 | 155,463.72 |
| Total | ..... | 43,518.74 | 141,551.06 | 26,403.19 | 148,431.37 | 359,904.36 |
| Ores worked this year | ..... | 35,137.21 | 78,512.30 | 25,382.00 | 28,837.28 | 167,868.79 |
| Ores on hand for following year | ..... | 8,381.53 | 63,038.76 | 1,021.19 | 119,594.09 | 192,035.57 |

*Table of ore worked and quicksilver obtained.*

| | Number of calcinations. | Net quintals of ore worked. | Net quintals of quicksilver obtained. | Yield, per cent. |
|---|---|---|---|---|
| S. Pedro y S. Pablo | 147 | 14,017.75 | 1,334.568 | 9.520 |
| Atocha y Almudena | 147 | 14,028.75 | 1,353.986 | 9.651 |
| S. Antonio y Sto Domingo | 148 | 14,129.43 | 1,371.034 | 9.703 |
| Larrañaga y Prado | 144 | 13,920.08 | 1,329.405 | 9.550 |
| S. Carlos y S. Sebastian | 144 | 12,327.57 | 1,351.427 | 10.963 |
| Sta. Cruz y Stos. Reyes | 143 | 12,280.39 | 1,319.705 | 10.746 |
| Cavanillas y Caravantes | 143 | 12,268.59 | 1,350.061 | 11.004 |
| Monasterio y Buceta | 143 | 12,310.79 | 1,355.555 | 11.011 |
| S. Carlos y S. Luis | 68 | 21,619.95 | 1,822.407 | 8.429 |
| S. Miguel y S. Benito | 148 | 14,116.63 | 1,386.992 | 9.825 |
| S. Fermin y S. Francisco | ..... | 9,768.52 | 460.441 | 4.713 |
| S. Eugenio y S. Julian | 146 | 14,736.59 | 1,339.444 | 9.089 |
| Horno de Canales | ..... | 2,343.75 | 147.653 | 6.300 |
| Total | 1,521 | 167,868.79 | 15,922.678 | 9.458 |

*Other countries.*—During the year 1885 a company was formed in London for developing the deposits near Kilkivan, Queensland. Shafts and tunnels have been made on a number of veins, and a considerable amount of ore exposed; further, a few tons of quicksilver have been extracted and sold to the miners in Queensland. No statement has been made of the percentage yield, and the future of an enterprise working in opposition to such established works as the Almaden is doubtful. The discovery of a new and very pure deposit of cinnabar at Schuppiastena, near Belgrade, is reported. Being in a mining region it is possible that the deposit may be used. Small amounts of quicksilver are annually produced in Hungary as is seen in the following table, taken from the "Mineral Resources of Hungary."

*Production of quicksilver in Hungary.*

| Years. | Metric tons. |
|---|---|
| 1864 | 33 |
| 1865 | 40 |
| 1866 | 55 |
| 1867 | 61 |
| 1868 | 45 |
| 1869 | 35 |
| 1870 | 25 |
| 1871 | 18 |
| 1872 | 15 |
| 1873 | 14 |
| 1874 | 13 |
| 1875 | 18 |
| 1876 | 22 |
| 1877 | 26 |
| 1878 | 25 |
| 1879 | 24 |
| 1880 | 18 |
| 1881 | 18 |
| 1882 | 16 |
| 1883 | 12 |

*Imports.*—In spite of the production of nearly half of the world's supply in this country, some quicksilver is imported; this amounted in 1885 to 257,659 pounds, valued at $90,416, nearly twice the importation of the previous year, but far less than in 1883. The importations of mercurial preparations was formerly noteworthy, as given in the following tables:

*Quicksilver imported and entered for consumption in the United States,* 1867 *to* 1884 *inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Pounds.* | | | *Pounds.* | |
| 1867 | | $15,248 | 1877 | 38,250 | $19,558 |
| 1868 | 152 | 68 | 1878 | 294,207 | 135,178 |
| 1869 | | 11 | 1879 | 519,125 | 217,770 |
| 1870 | 239,223 | 107,646 | 1880 | 116,700 | 48,463 |
| 1871 | 304,965 | 137,332 | 1881 | 138,517 | 57,733 |
| 1872 | 370,353 | 189,943 | 1882 | 597,898 | 233,057 |
| 1873 | 99,898 | 74,146 | 1883 | 1,552,758 | 593,367 |
| 1874 | 51,202 | 52,093 | 1884 | 136,615 | 44,035 |
| 1875 | 6,870 | 20,957 | 1885 | 257,659 | 90,416 |
| 1876 | 78,902 | 50,164 | | | |

*Mercurial preparations imported and entered for consumption in the United States,* 1867 *to* 1883 *inclusive* (*a*)

| Fiscal years ending June 30— | Blue-mass. | | Calomel. | | Mercurial preparations not otherwise specified. | Total value. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | | |
| | *Pounds.* | | *Pounds.* | | | |
| 1867 | | | | $4,242 | | $2,242 |
| 1868 | | | | 4,440 | | 4,440 |
| 1869 | | | | 4,516 | | 4,516 |
| 1870 | | | | 6,306 | | 6,306 |
| 1871 | | | | 3,147 | | 3,147 |
| 1872 | 1,009 | $667 | 8,241 | 6,590 | $629 | 7,886 |
| 1873 | 919 | 660 | 5,520 | 5,240 | 699 | 6,599 |
| 1874 | 259 | 192 | 6,138 | 6,676 | 4,334 | 11,202 |
| 1875 | 125 | 109 | 2,424 | 2,817 | 52 | 2,978 |
| 1876 | 489 | 365 | 5,433 | 5,820 | 92 | 6,277 |
| 1877 | 455 | 327 | 4,649 | 4,305 | 90 | 4,722 |
| 1878 | 397 | 252 | 4,133 | 3,576 | 363 | 4,191 |
| 1879 | 485 | 266 | 5,875 | 4,635 | 6,453 | 11,354 |
| 1880 | 523 | 262 | 4,780 | 3,330 | 30 | 3,622 |
| 1881 | 395 | 236 | 8,177 | 5,640 | 116 | 5,992 |
| 1882 | 207 | 124 | 5,215 | 3,411 | 58 | 3,593 |
| 1883 | 188 | 79 | 8,732 | 5,503 | 190 | 5,772 |

*a* Not specified in 1884 and 1885.

*Exports.*—It will be seen by the following tables that the production of California is distributed widely. Under the head of exports by sea is included all the quicksilver to New York. Some of this is then exported to England and elsewhere, while another portion is consumed in the manufacture of vermilion and in the applications of quicksilver in the arts. There was a marked increase in these shipments to New York during 1884, which was continued in 1885 The total exports from San Francisco increased from 21,901 flasks in 1884 to 25,730 in 1885. This increased exportation is not due to the slight increase in production, and it caused a drain on the accumulated stock, which was reduced to less than 1,000 flasks. The yearly exports since 1854 are shown in the following tables:

*Quicksilver of domestic production exported from the United States.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Pounds.* | | | *Pounds.* | |
| 1854 | | $94,335 | 1870 | 1,200,385 | $511,918 |
| 1855 | | 806,119 | 1871 | 994,005 | 732,845 |
| 1856 | | 831,724 | 1872 | 862,694 | 691,637 |
| 1857 | | 665,480 | 1873 | 714,783 | 626,021 |
| 1858 | | 129,184 | 1874 | 501,389 | 580,521 |
| 1859 | | | 1875 | 986,469 | 1,075,796 |
| 1860 | | 258,682 | 1876 | 2,711,584 | 1,740,293 |
| 1861 | | 631,450 | 1877 | 3,894,311 | 1,767,266 |
| 1862 | | 1,237,043 | 1878 | 2,552,388 | 1,230,008 |
| 1863 | | 1,237,116 | 1879 | 3,624,827 | 1,418,331 |
| 1864 | 1,736,596 | 976,868 | 1880 | 3,574,412 | 1,360,176 |
| 1865 | | 1,629,063 | 1881 | 2,955,948 | 1,124,955 |
| 1866 | 2,948,699 | 1,508,039 | 1882 | 2,485,551 | 959,128 |
| 1867 | 1,736,924 | 750,673 | 1883 | 2,762,554 | 1,020,827 |
| 1868 | 2,995,789 | 1,220,869 | 1884 | 1,242,080 | 427,219 |
| 1869 | 2,152,499 | 869,803 | 1885 | 516,867 | 206,630 |

*Movement of quicksilver from San Francisco by sea and rail.*

| Years. | Flasks. | Years. | Flasks. |
|---|---|---|---|
| 1850 | 6,467 | 1868 | 44,506 |
| 1851 | 10,791 | 1869 | 24,415 |
| 1852 | 21,458 | 1870 | 14,240 |
| 1853 | 18,800 | 1871 | 16,339 |
| 1854 | 20,993 | 1872 | 16,780 |
| 1855 | 27,165 | 1873 | 11,164 |
| 1856 | 23,740 | 1874 | 11,750 |
| 1857 | 27,262 | 1875 | 37,829 |
| 1858 | 24,412 | 1876 | 49,046 |
| 1859 | 3,399 | 1877 | 52,695 |
| 1860 | 9,488 | 1878 | 41,877 |
| 1861 | 35,995 | 1879 | 62,845 |
| 1862 | 23,747 | 1880 | 46,294 |
| 1863 | 26,014 | 1881 | 45,799 |
| 1864 | 36,927 | 1882 | 40,417 |
| 1865 | 42,469 | 1883 | 37,867 |
| 1866 | 30,287 | 1884 | 21,901 |
| 1867 | 28,853 | 1885 | 25,730 |

The shipments shown in this and in the following table do not include supplies sent to local and Nevada precious-metal mines.

*Movement of quicksilver from San Francisco in* 1883, 1884, *and* 1885 *in detail.*

| To— | 1883. | 1884. | 1885. | Increase. | Decrease. |
|---|---|---|---|---|---|
| By sea: | *Flasks.* | *Flasks.* | *Flasks.* | *Flasks.* | *Flasks.* |
| China | 16,330 | 200 | 233 | 33 | ..... |
| Japan | 1,253 | 588 | 302 | ..... | 286 |
| Mexico | 10,764 | 5,404 | 5,884 | 480 | ..... |
| South America | 970 | 155 | 100 | ..... | 55 |
| Australia | 600 | 110 | ..... | ..... | 110 |
| New Zealand | 160 | 20 | 100 | 80 | ..... |
| Central America | 59 | 52 | 9 | ..... | 43 |
| New York | 3,100 | 8,350 | 9,055 | 705 | ..... |
| Various | 11 | 22 | 47 | 25 | ..... |
| Total by sea | 33,247 | 14,901 | 15,730 | 829 | ..... |
| By rail: | | | | | |
| Central Pacific, Southern Pacific, and Northern Pacific railroads | 4,620 | (*a*)7,000 | (*a*)10,000 | 3,000 | ..... |
| Grand total | 37,867 | 21,901 | 25,730 | 3,829 | ..... |

*a* Including about 3,500 flasks to Mexico by Southern Pacific railroad.

*Movement of quicksilver in London.*—The following tables give a summary of the imports and exports of quicksilver for the past three years, and an estimate of the accumulated stock at the end of each year:

*London imports and exports of quicksilver.*

| Years. | Imports. | Exports. | Estimated stock on hand December 31. |
|---|---|---|---|
| | *Flasks.* | *Flasks.* | *Flasks.* |
| 1883 | 54,519 | 48,997 | ..... |
| 1884 | 56,969 | 52,492 | 74,000 |
| 1885 | 55,154 | 48,822 | 65,500 |

The detailed statement of imports for each month of 1885 are given below:

*Monthly imports of quicksilver into England in* 1885.

| Months. | Flasks. |
|---|---|
| January | 4,350 |
| February | 4,603 |
| March | 8,434 |
| April | 329 |
| May | 9,545 |
| June | 21,328 |
| July | 427 |
| August | 1,607 |
| September | 300 |
| October | 2,057 |
| November | 474 |
| December | 1,700 |
| Total | 55,154 |

*Uses.*—In addition to the use of quicksilver in the amalgamation process of gold and silver mining, about 530,000 pounds are consumed yearly in the production of quicksilver vermilion, of which an account by Mr. Marcus Benjamin is given below.

*Vermilion.*—The production of this pigment from quicksilver is controlled by a syndicate, consisting of four firms as follows: C. T. Raynolds & Co., D. F. Tiemann & Co., Sondheim, Alsberg & Co., and A. B. Ansbacher & Co., all of New York City. The process of manufacture, which is an exceedingly difficult one, requiring much skill and delicacy of manipulation, is kept secret by the combination. In a general way it is said to consist in bringing quicksilver, sulphur, and an aqueous solution of caustic potash together in a revolving drum. The mixture is gently heated until a temperature of 115° F. is reached; this heat is then kept constant and the reddening action proceeds. The methods of manufacture differ somewhat with each maker. From 85 to 90 pounds of quicksilver are necessary in order to produce 100 pounds vermilion. The quicksilver used is bought on the open market and that which is cheapest at the time is purchased, so that the exact amount of American or foreign quicksilver used in the production of vermilion cannot be estimated.

The output of American vermilion made from quicksilver during 1885 by this syndicate is estimated at 600,000 pounds. The ruling price during this time was 52 cents in bulk, 53 cents in bags, and 57 cents in smaller quantities. A small amount of quicksilver vermilion, perhaps 10,000 pounds, is annually imported into the United States, but its high price, 65 to 70 cents per pound, prevents any great demand for it.

*Prices of vermilion.*

| Vermilion. | Cents per pound. |
|---|---|
| American quicksilver, in bulk | 52 to .... |
| American quicksilver, in bags | 53 to 60 |
| Chinese | 65 to 80 |
| Imported English | 65 to 70 |
| Trieste | 70 to 72½ |
| American | 10½ to 11 |
| Artificial | 10 to 25 |

Foreign vermilion is not regarded as having any influence upon the demand for American, which was active during 1885. The production of the latter, however, has been very seriously affected by the introduction of numerous varieties of imitation vermilion. These products have already been described on page 502 of the "Mineral Resources of the United States, 1883 and 1884," and need no further mention beyond the statement that the production of orange mineral (see page 524) has been largely augmented during the past year by its use with certain anilines in making these low grades of artificial vermilion.

# NICKEL.

*Production.*—As in previous years, the production of metallic nickel in the United States was limited during 1885 to the American Nickel works in Camden, New Jersey, where ore in the form of nickeliferous pyrrhotite from the Gap mine, Lancaster county, Pennsylvania is smelted. The works were in operation throughout the year and produced 245.504 pounds of "grain" nickel, valued at $169,397. Besides the amount of metallic nickel given above, matte containing nickel and cobalt was made at Mine la Motte, Missouri, containing in all 14,400 pounds of nickel, all of which was exported to England and Germany. Nickel ore, to the extent of 90 short tons, was also exported from Nevada; it was estimated to contain in all about 18,000 pounds of nickel. The total production of nickel ore and matte was equivalent therefore to 277,904 pounds of metallic nickel, valued at about $190,000. The production of metallic nickel, and also the amounts of matte and ore, is summarized in the following tables:

*Annual production of metallic nickel in the United States from* 1876 *to* 1885 *inclusive.*

| Years. | Pure grain nickel. | Nickel contained in copper-nickel alloy. | Total. | Average price per pound. | Value. |
|---|---|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Pounds.* | | |
| 1876 | ..... | ..... | 201, 367 | $2. 60 | $523, 554 |
| 1877 | ..... | ..... | 188, 211 | 1. 60 | 301, 138 |
| 1878 | ..... | ..... | 150, 890 | 1. 10 | 165, 979 |
| 1879 | ..... | ..... | 145, 120 | 1. 12 | 162, 534 |
| 1880 | ..... | ..... | 233, 893 | 1. 10 | 257, 282 |
| 1881 | ..... | ..... | 265, 668 | 1. 10 | 292, 235 |
| 1882 | 277, 034 | 4, 582 | 281, 616 | 1. 10 | 309, 777 |
| 1883 | 6, 500 | 52, 300 | 58, 800 | .90 | 52, 920 |
| 1884 | ..... | 64, 550 | 64, 550 | .75 | 48, 412 |
| 1885 | ..... | ..... | 245, 504 | .69 | (a)169, 398 |

(a) Not including value of nickel in ore and matte.

*Total production of nickel in* 1885.

| | Pounds. |
|---|---|
| Metallic nickel | 245, 504 |
| Nickel in ore and matte | 32, 400 |

*Price.*—The average price of American nickel in 1885 was 69 cents per pound. The price paid by the Mint for German nickel was 5.7

cents per Troy ounce. The range in price of nickel for the last ten years is given in the table of production. The price is still declining in consequence of the forced sales of the product of the New Caledonia mines.

*Imports and exports.*—The following tables show the amounts of nickel and nickel alloys imported, and the values of manufactured nickel, nickel coin, and nickel ore exported from the United States:

*Nickel imported and entered for consumption in the United States, 1868 to 1885 inclusive.*

| Fiscal years ending June 30— | Nickel. | | Oxide and alloy of nickel with copper. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | |
| 1868 | ..... | $118,058 | ..... | ..... | $118,058 |
| 1869 | ..... | 134,327 | ..... | ..... | 134,327 |
| 1870 | ..... | 99,111 | ..... | ..... | 99,111 |
| 1871 | 17,701 | 48,133 | 4,438 | $3,911 | 52,044 |
| 1872 | 26,140 | 27,144 | ..... | ..... | 27,144 |
| 1873 | 2,842 | 4,717 | ..... | ..... | 4,717 |
| 1874 | 3,172 | 5,883 | ..... | ..... | 5,883 |
| 1875 | 1,255 | 3,157 | 12 | 36 | 3,193 |
| 1876 | ..... | ..... | 156 | 10 | 10 |
| 1877 | 5,978 | 9,522 | 716 | 824 | 10,346 |
| 1878 | 7,486 | 8,837 | 8,518 | 7,847 | 16,684 |
| 1879 | 10,496 | 7,829 | 8,314 | 5,570 | 13,399 |
| 1880 | 38,276 | 25,758 | 61,869 | 40,311 | 66,069 |
| 1881 | 17,933 | 14,503 | 135,744 | 107,627 | 122,130 |
| 1882 | 22,906 | 17,924 | 177,822 | 125,736 | 143,660 |
| 1883 | 19,015 | 13,098 | 161,159 | 119,386 | 132,484 |
| 1884 | ..... | ..... | 194,711 | 129,733 | 129,733 |
| 1885 | ..... | ..... | 105,603 | 64,166 | 64,166 |

*Value of exports of nickel and nickel ore of domestic production from the United States.*

| Fiscal years ending June 30— | Manufactured nickel. | Nickel coin. | Nickel ore. |
|---|---|---|---|
| 1864 | ..... | ..... | $25,494 |
| 1865 | ..... | ..... | 36,710 |
| 1869 | ..... | ..... | 11,350 |
| 1872 | ..... | ..... | 43,500 |
| 1873 | $19,780 | ..... | 19,891 |
| 1874 | 16,062 | ..... | 75,696 |
| 1875 | 26,000 | ..... | 72,020 |
| 1876 | 168,050 | ..... | 35,100 |
| 1877 | 8,200 | ..... | ..... |
| 1878 | ..... | ..... | 2,452 |
| 1880 | 4,120 | ..... | ..... |
| 1881 | 6,600 | $32,880 | ..... |
| 1882 | 12,474 | 7,200 | ..... |
| 1883 | 9,911 | ..... | 12,182 |
| 1884 | ..... | ..... | (a)22,249 |
| 1885 | 1,223 | ..... | 10,500 |

a Classed as "nickel and cobalt ore."

*New occurrences of nickel.*—Mr. C. G. Yale states that besides the localities mentioned in the last volume of this report, the various ores of nickel occur at the following places in California: The sulphide has been observed on the Central Pacific railroad in Placer county. A nickel ore also occurs with chrome iron at Panoches, Gabilan mountains, at Cañada, San Benito, and elsewhere in the Coast range mount-

ains. At none of these places does the ore occur in quantity. From the deposits discovered several years since in Cottonwood cañon, Churchill county, Nevada, some ore averaging 8 per cent. nickel was extracted last year, and shipped to Europe. Although these deposits are not so extensive as at first reported, much more ore might have been extracted had the business proved profitable, which it did not, owing to the low grade of the ore and the cost ($18 per ton) of hauling to the railroad. The work of prospecting is still continued at this place, in the hope of finding the deposits more concentrated and the ore of a better grade. The mines are reported to have been sold to English capitalists having the intention of erecting extensive reduction works. With the nickel deposits in Oregon, described in the first volume of these reports, nothing has been done, though there is little doubt of their value and extent. That they will be worked on a large scale as soon as the railroad is completed, which is to pass within a few miles of them, is altogether probable. Mr. F. F. Chisolm reports that the vein in the Gem mine, in Custer county, Colorado, has been lost, and no ore can now be found in the mine. This is the only mine in Colorado where any attempt has been made to ship nickel ores. The occurrence of the mineral in other places is so slight as to preclude the possibility of regular shipments.

*Foreign sources of nickel.*—The chief foreign sources of nickel, with which the United States must as yet be regarded as a minor competitor, have been given in former reports. With the exception of an effort of very questionable value in the direction of increasing the home production of Germany, by developing the Hessian mines near Gladenbach, there has been little change in European mines during the year. The market has been controlled altogether, however, by the mines of New Caledonia. An admirable treatise upon the present condition of these mines is taken from the *Iron Age* as follows:

*The production of nickel in New Caledonia*—Only a few years since, industrial circles were aroused by the discovery in New Caledonia of highly important deposits of nickel. A company was formed in France to work them, acquiring the patents of Garnier, and building works for treating the ore and refining the metal at Septemes, near Marseilles, where the vessels from Noumea discharged. Later these works were abandoned for a plant at Birmingham. The capital was increased, an alliance formed with a great metallurgical establishment at Glasgow to work other metals besides, like chromium, cobalt, antimony, etc. The abundance and the richness of the New Caledonia deposits, and the strong financial backing of the enterprise, seemed to assure for it a bright future. It was expected that nickel, produced at a low price, would displace copper in many directions, and that the production would keep pace with the steadily growing consumption at gradually declining prices. Such, according to M. Charles du Peloux, in the *Génie Civil*, was the outlook in 1882. Now, four years since, the works

at Noumea are closed down, and work at the mines is reduced to what is absolutely necessary. M. du Peloux explains this outcome in a very interesting review of the conditions affecting the New Caledonian mines.

The ore, known as "garnierite," is a hydrosilicate of nickel and magnesia, and is found at a great number of points in Caledonia—in fact, it may be stated that, with the exception of the northeast end, traces of nickel may be found in all parts of the island, which is made up of more or less decomposed eruptive rocks, among which serpentine plays the most important part. The nickel ore is always found in the beds of serpentine. Still, though apparently so abundant, the ore is found in quantity and accessible in workable deposits only at a very few points in the districts along the northeast coast of the island. After examination, these rich regions are reduced to three principal districts, named Canala-Méré-Kuana, Thio-Port Bouquet, and Bourindi. They are, properly speaking, detached districts without any connection geographically, but are simply the points of maximum grade above the entire belt. The Canala-Honailou group was the first worked, and, while it had many rich veins, the grade was too low, the workings too much scattered, and transportation too difficult to make it profitable. It has been abandoned. The Thio group, which was then taken in hand, is the only one now being worked. It is the best known and is considerably nearer Noumea. Although it has been well developed in all directions during the past six years it is far from being exhausted. It consists of an important central group, and two others at quite a distance from it. The third district, the Bourindi, is probably justly considered the richest on the island, both for quantity and grade of ore. It is nearest Noumea, and has not been touched as yet. It is kept as a reserve.

The veins, so far as strike and dip are concerned, are fairly regular, striking north-northeast and south-southwest and dipping almost vertically. But the contents vary widely and suddenly in grade. The veins are not very persistent, and it is asserted, after experience which must be considered final, that they do not descend deeper than 300 to 500 feet, even that depth being very rare. The ore is mined by the usual methods, and is sorted by hand at the mine and sacked. M. du Peloux describes in detail how frequently the ore is handled, evidently disapproving of it; he enumerates that the ore of the Thio district, which is best equipped with means of transportation, is handled twelve times. This is partly due to the fact that the sacks are taken to the river bank, the bar at the mouth of which they can only cross at flood tide, and that the beach is so shallow that the ore must again be lightered to the sea-going vessels in the offing, which carry it to the smelting works at Noumea. Thus the irregularity of the ore distribution and the high cost of transportation greatly increase the expense of mining. To this must be added the scarcity of suitable labor in New Caledonia. Among the force available are, first, those transported criminals who are liberated with residence restricted to the colony.

They are lazy and difficult to handle. They receive from 6 to 9 francs for eight hours' work. Then there are the natives of the New Hebrides islands engaged under supervision of the government for a period of three to five years. Although apparently cheap labor, they cost 3 francs a day, are unfit to work in the mines, and are unable to adapt themselves to the climate, from 25 to 30 per cent. always being in the hospital, where the majority die. Their immigration has been finally prohibited by the French Government. The Australians are fair miners and good workmen, but they demand at least 12.50 francs a day. Latterly Chinese laborers have been brought in, and give better promise, although they require constant watching. Added to the high cost of labor, as compared with European standards, there is often trouble through want of water.

The ore is taken in lots of 200 to 250 tons to Noumea, where it is worked in two blast furnaces, one of which is used for nickel ores alone, and the other for mixed ores of nickel and cobalt. The charcoal and coke come from Australia, and, in spite of the proximity of the two colonies, are very dear. Charcoal costing 12.50 francs at Sydney is worth 40 francs at Noumea, while coke sells at 70 to 80 francs. The object in smelting the ore is to produce a matte carrying from 60 to 70 per cent. of metal. It is granulated and shipped to England.

The production of nickel is far greater than the consumption, and this is the principal reason which has led to the temporary suspension of the working. The sale of the metal was considered too easy a matter. Production was pushed too fast, and thus the company was finally brought face to face with an enormous stock. In April, 1884, the product of the Thio mines had reached 1,000 tons a month and orders came to increase it even then. With the usual grade, this represented an annual production of 850 tons of metal. During the years 1882, 1883, and 1884 the Caledonia company have thrown on the market about 2,400 tons of pure nickel. It may be estimated that in those three years the European and American mines marketed a total of 600 tons, carrying the aggregate for three years to 3,000 tons, or 1,000 tons per annum. Now the consumption is probably not greater than 700 to 800 tons, if it reaches that figure. At present prices, ranging between 6 and 7 francs, the profits are small. M. du Peloux, however, believes that the cost may be reduced so that the company can sell at 4 to 5 francs and yet have a good profit, and that in spite of the temporary stoppage the future is full of promise.

*Use.*—Contrary to normal industrial development, the production of nickel has increased considerably beyond the demands for the metal. Stocks have accumulated repeatedly, resulting in cessation of production in various parts of the world until this stock could be cleared off. The expectation that the use of malleable alloys of nickel would increase the consumption markedly has not yet been fulfilled. The production of such alloys lingers in the experimental stage. Switzerland coined 20-centime

pieces in pure nickel last year succesfully, and it is proposed to coin 5, 10, and 20 centime pieces in France. The use of nickel in American coinage is given in the following table. The nickel so used in 1885 was all of German manufacture and was applied only to 3 and 5 cent pieces.

*Nickel coinage of the United States.*

| Calendar years. | One-cent nickel coins. | | Three-cent nickel coins. | | Five-cent nickel coins. | | Pure nickel consumed. |
|---|---|---|---|---|---|---|---|
| | Pieces. | Value. | Pieces. | Value. | Pieces. | Value. | |
| | | | | | | | *Troy ounces.* |
| 1857 | 17,432,410 | $174,324.10 | | | | | 313,931.92 |
| 1858 | 24,600,000 | 246,000.00 | | | | | 443,731.22 |
| 1859 | 36,400,000 | 364,000.00 | | | | | 637,687.87 |
| 1860 | 20,566,000 | 205,660.00 | | | | | 391,199.20 |
| 1861 | 10,100,000 | 101,000.00 | | | | | 181,076.48 |
| 1862 | 28,375,000 | 283,750.00 | | | | | 505,320.42 |
| 1863 | 49,840,000 | 498,400.00 | | | | | 895,878.04 |
| 1864 | 13,170,000 | 131,700.00 | | | | | 237,049.00 |
| 1865 | | | 11,382,000 | $341,460.00 | | | 165,955.08 |
| 1866 | | | 4,801,000 | 144,030.00 | 14,742,500 | $737,125.00 | 674,553.54 |
| 1867 | | | 3,915,000 | 117,450.00 | 30,909,500 | 1,545,475.00 | 1,307,978.08 |
| 1868 | | | 3,252,000 | 97,560.00 | 28,817,000 | 1,440,850.00 | 1,213,242.65 |
| 1869 | | | 1,604,000 | 48,120.00 | 16,395,000 | 819,750.00 | 688,017.22 |
| 1870 | | | 1,335,000 | 40,050.00 | 4,806,000 | 240,300.00 | 215,171.62 |
| 1871 | | | 604,000 | 18,120.00 | 561,000 | 28,050.00 | 32,591.00 |
| 1872 | | | 862,000 | 25,860.00 | 6,036,000 | 301,800.00 | 215,303.32 |
| 1873 | | | 1,173,000 | 35,190.00 | 4,550,000 | 227,500.00 | 110,057.07 |
| 1874 | | | 790,000 | 23,700.60 | 3,538,000 | 176,900.00 | 76,772.51 |
| 1875 | | | 228,000 | 6,840.00 | 2,097,000 | 104,850.00 | 21,135.36 |
| 1876 | | | 162,000 | 4,860.00 | 2,530,000 | 126,500.00 | 2,688.42 |
| 1877 | | | | | | | |
| 1878 | | | 2,350 | 70.50 | 2,350 | 117.50 | 132.90 |
| 1879 | | | 41,200 | 1,236.00 | 29,100 | 1,455.00 | 1,821,78 |
| 1880 | | | 24,955 | 748.65 | 19,955 | 997.75 | 1,197.32 |
| 1881 | | | 1,080,575 | 32,417.25 | 72,375 | 3,618.75 | 10,595.16 |
| 1882 | | | 25,300 | 759.00 | 11,476,600 | 573,830.00 | 344,553.71 |
| 1883 | | | 10,609 | 318.27 | 22,969,421 | 1,148,471.05 | 703,426.73 |
| 1884 | | | 5,642 | 169.26 | 11,273,942 | 563,697.10 | 399,141.37 |
| 1885 | | | 4,790 | 143.70 | 1,476,490 | 73,824.50 | 58,615.82 |
| Total | 200,483,410 | 2,004,834.10 | 31,303,421 | 939,102.63 | 162,302,233 | 8,115,111.65 | 9,848,734.81 |

# MANGANESE.

By Jos. D. Weeks.(a)

The general subject of the occurrence, uses, and character of manganese ores, as well as the localities in the United States in which they are found, were discussed at length in Dr. Day's report on manganese in the last volume of "Mineral Resources." To that report those interested are referred for more definite information than is here given.

In the present report the ores containing manganese which are described are divided into two classes, manganese ores and manganiferous iron ores. Some difficulty was experienced in deciding upon the percentage of manganese that should constitute the dividing line between these two grades. The percentage which is the standard of shipments in English chemical works was adopted, that is, 70 per cent. of binoxide, which equals 44.252 parts of the metal per 100. It is to be understood, however, that ores containing less than this percentage of metallic manganese are used in the manufacture of high manganese spiegel and ferromanganese, while some ores with manganese in excess of this may be used for low spiegels. It is also to be noted that all ores that are utilized for their manganese, without reference to the percentage contained, are reported in the tables of production. To these should be added the high manganese ores of Montana, utilized for their silver contents and the fluxing properties of the manganese.

A word as to the ores of manganese. Those utilized in this country are, with scarcely an exception, oxides. Four oxides are noted:

*Protoxide* (MnO), known also as the monoxide or manganous oxide. Multiplying the amount of the protoxide or MnO in an ore by .7746 will give the contents of metallic manganese in the ore.

*Sesquioxide* ($Mn_2O_3$), *braunite*, *brown oxide*, known also as manganic oxide. This oxide occurs in nature as braunite and in the state of hydrate as *manganite* ($Mn_2O_3$, $H_2O$). This, in the form of braunite, is one of the most important ores of manganese occurring in this country. Multiplying the amount of sesquioxide ($Mn_2O_3$) in an ore by .6392 will give the amount of metallic manganese in the ore.

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*Peroxide* ($MnO_2$) *pyrolusite, black oxide.*—This is, with braunite, the most common ore of manganese in the United States. Psilomelane contains the peroxide. Multiplying the amount of peroxide ($MnO_2$) in an ore by .63218 will give the amount of metallic manganese in the ore.

*Hausmannite* is a brown manganese oxide containing theoretically 72.1 per cent. of metallic manganese.

*Localities in the United States.*—The localities in this country in which manganese is found will be given in detail when discussing its occurrence in the different States. It only need be said here that it has a distribution almost coextensive with the deposits of the brown hematite ores of the country. In almost all of these ores manganese occurs as a constituent. At times the manganese displaces so much of the iron as to make the ore a manganiferous iron ore, while, at other times, in close association with the iron ores, veins or pockets of manganese ores will be found. This statement is especially true of the hematite ore beds of the great Appalachian chain of mountains from the northern to the southern extremity. It is particularly noticeable in Virginia.

Though manganese is found in many sections, there are but three, possibly four, localities that yielded any amount of ore in 1885, the Crimora mines, in Virginia; Cartersville, Georgia; and Batesville, Arkansas. To these the Mount Athos or Leet's mine, Virginia, should be added. The Crimora mine is much the more important, yielding two-thirds of all the manganese mined in the country in 1885.

In addition to these there were two localities in Virginia that produced some manganiferous iron ore in 1885, the Houston mines and those of the Shenandoah Iron company.

*Origin of manganese ore.*—There is no more interesting question, geologically, than the origin of manganese. This report will not attempt to solve the question, but all information that could be gathered as to the occurrence of the several deposits thus far discovered has been brought together in the hope that it would aid in its solution. It is evident that its origin is similar to that of hematite ores, that it has been deposited from solution, and that lime has been one of the agents in its deposition. Possibly this accounts for the fact that the manganese deposits seem to contain less phosphorus than the rocks from which they have leached.

It is also remarkable that so far as known the valuable deposits of manganese have been in pockets, usually embedded in a tenacious clay which requires washing to remove.

*Production and value in the United States.*—The production of manganese and manganiferous iron ores in the United States in 1885 was 26,495 long tons, of which 23,258 tons were manganese ores, or those averaging more than 44.252 per cent. of metallic manganese, and 3,237 tons manganiferous iron ore, or ores carrying less than this 44¼ per cent. of manganese, but still high enough to be utilized for this metal. The amount of metallic manganese in these manganiferous iron ores was from 31 per cent. to 45 per cent., averaging 39 per cent.

The distribution of this production was as follows:

*Production of manganese ore in the United States in* 1885.

| Locality. | Production. |
|---|---|
| | *Long tons.* |
| Virginia: | |
| Augusta county: | |
| Crimora | 18,212 |
| Campbell county: | |
| Mount Athos (Leet's) | 500 |
| Bishop mine | 13 |
| Rockbridge county: | |
| Guy's Run | 20 |
| Total, Virginia | 18,745 |
| Georgia: | |
| Cartersville | 2,580 |
| Arkansas: | |
| Batesville | 1,483 |
| California | 200 |
| Nevada | 200 |
| Other localities, small amounts | 50 |
| Total manganese ore | 23,258 |
| Add manganiferous iron ores, Virginia | 3,237 |
| Total | 26,495 |

To the above should be added the argentiferous manganese ores of Montana utilized for their silver, amounting to 4,263 tons in 1885.

Virginia produced 18,745 tons, or 80.6 per cent. of the 23,258 tons of manganese ores produced in the country in 1885, and all of the manganiferous iron ore. The Crimora mine produced all but 533 tons of the manganese ores produced in Virginia.

The value of this ore was as follows:

*Value of manganese ore and manganiferous iron ore produced in the United States in* 1885, *free on board at mines.*

| Locality. | Production. | Value. | |
|---|---|---|---|
| | | Per ton. | Total. |
| Virginia: | *Long tons.* | | |
| Crimora | 18,212 | $9.00 | $163,908 |
| Mount Athos | 500 | 9.50 | 4,750 |
| Bishop mine | 13 | 9.50 | 124 |
| Guy's Run | 20 | 8.00 | 160 |
| Total, Virginia | 18,745 | 9.01+ | 168,942 |
| Georgia: | | | |
| Cartersville | 2,580 | 5.19 | 13,390 |
| Arkansas: | | | |
| Batesville | 1,483 | 4.00 | 5,932 |
| California | 200 | 5.00 | 1,000 |
| Nevada | 200 | 3.00 | 600 |
| Other localities | 50 | 8.34 | 417 |
| Total for United States | 23,258 | 8.18 | 190,281 |
| Manganiferous iron ore, Virginia | 3,237 | 5.35 | 17,318 |
| Total manganese and manganiferous iron ore | 26,495 | 7.83+ | 207,599 |

It is almost impossible to arrive at the production of manganese for the years prior to 1885. In the last volume of "Mineral Resources" it is

estimated that 8,000 tons were mined in 1883 and 10,000 tons in 1884, and that of these amounts Virginia furnished fully three-fourths, Arkansas a fifth, and the balance was contributed by Georgia and North Carolina. I have been able to learn of the following amounts mined in each of the years from 1880. With the exception of 1885, the table is not given as including all the ore mined, but as the best approximation to the actual facts:

*Production of manganese ores (over 44½ per cent. of metallic manganese) in the United States, 1880–'85.*

| States. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Virginia | 3,661 | 3,295 | 2,982 | 5,355 | 8,980 | 18,745 |
| Arkansas | ..... | 100 | 175 | 400 | 800 | 1,483 |
| Georgia | 1,800 | 1,200 | 1,000 | ..... | ..... | 2,580 |
| Other States | 300 | 300 | 375 | 400 | 400 | 450 |
| Total | 5,761 | 4,895 | 4,532 | 6,155 | 10,180 | 23,258 |

The Virginia production is very nearly correct; as to Arkansas there is considerable doubt. There is a strange reluctance on the part of those who could give a statement of the amounts mined to impart the information. This it may be said is the only case of refusal. Georgia's figures are those of shipments.

The value given for the manganese mined in 1885 is that of ore on cars or carts at the mine, and not the price at points of consumption nor of distribution other than the mine itself. It is understood that this was not the basis adopted in the previous report, as the price for 1883 is put at $11 to $16, and for 1884 at $12 for 75 per cent. manganese dioxide. The greater part of the Crimora ore, which was the bulk of the ore mined, sold for much less than this at the mine; an average of $8.50 in 1884 and of $9 in 1883 would be approximately correct.

*Production of spiegel iron and ferro-manganese.*—Spiegel iron and ferro-manganese were produced in 1885 in two States, New Jersey and Pennsylvania, and at five works; those of the New Jersey Zinc Company and the Passaic Zinc Company, of New Jersey, and the Lehigh Zinc and Iron Company, the Cambria Iron Company, and the Edgar Thomson Steel Works, in Pennsylvania. The three first named use zinc residuum, the last two manganese ores.

The total production of spiegel iron and ferro-manganese in the country in 1885 was 30,955 long tons. In 1884 the production was 30,262 tons. Of the total made in 1885 the Edgar Thomson furnace A, at Pittsburgh, produced 7,218 long tons of ferro-manganese and 4,722 tons of spiegel iron.

In making a 20 per cent. spiegel iron, the ore must contain 38 per cent. iron and 15 per cent. manganese. Ores containing less than this proportion of iron and manganese must be mixed with others richer in both elements; these rich ores are scarcer in Europe, whilst ores contain-

ing 2 per cent. to 10 per cent. of manganese are abundant in Spain and Algeria. These ores are comparatively cheap, and can be used with economy with rich manganese ores of Virginia, Georgia, and Arkansas in making spiegel iron.

## VIRGINIA.

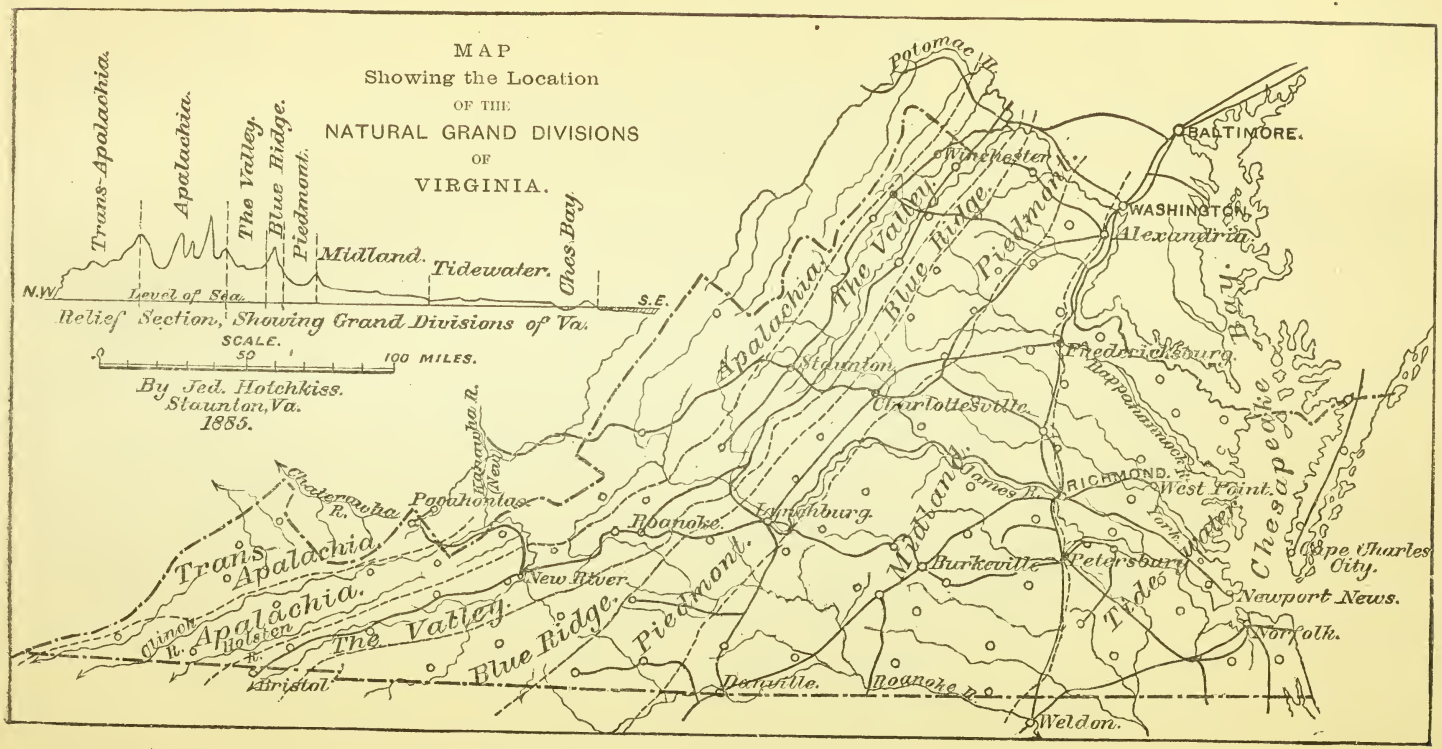
So far as explorations have been made, manganese ores have been found over a much greater extent of territory in Virginia than in any other of the United States. It is uncertain what future developments may prove to be true of other States, especially of Arkansas, but at present Virginia has more known deposits of this mineral, they are spread over a greater extent of territory, more localities have been worked, and more manganese has been raised.

As to the localities in this State in which manganese ore is found, Maj. Jed. Hotchkiss, mining editor of the *Industrial South*, in the first issue (January 6, 1886) of that journal after its consolidation with *The Virginias*, says:

"In the brief time and with the small means at my disposal to collect minerals from Virginia for the New Orleans World's Fair of 1884–85, without any special seeking, I had there on exhibition, manganese ores from thirty different localities in sixteen counties of the State. From Midland: from one in Spottsylvania; two in Louisa; one in Appomattox; four in Campbell; and two in Pittsylvania. From Piedmont: from one in Albemarle, and two in Nelson. From the Valley: from one in Shenandoah, two in Augusta, one in Rockbridge, four in Boutetourt, and one in Wythe. From Apalachia: from one in Bath, four in Craig, two in Bland, and one in Tazewell. I can recall as many more Virginia localities where I know of the existence of manganese ores, and hundreds of them can easily be found.

"Observation and experience have taught me that deposits of manganese almost invariably accompany those of iron, so that where the latter are abundant, more or less of the former may be confidently looked for. At least eight groups of the geological formations in Virginia are ferriferous; each of these contains more or less manganese. These iron ores are found in belts or bands, generally extending across the State in a northeast and southwest direction with the strike of the outcrops of the rocks as a rule, and with the general trend of the length of the natural grand divisions of the State."

In discussing the manganese deposits of Virginia it will be more convenient to arrange them in accordance with the natural divisions of the State mentioned in the extract just quoted. These divisions are (1) Tide-water; (2) Midland; (3) Piedmont; (4) The Blue Ridge; (5) The Valley; (6) Apalachia; (7) Trans-Apalachia. The boundaries of these divisions will appear from the accompanying map, for which I am indebted to Hon. Randolph Harrison, commissioner of agriculture of Virginia.


MAP
Showing the Location
OF THE
NATURAL GRAND DIVISIONS
OF
VIRGINIA.
Trans-Apalachia.
Apalachia.
The Valley.
Blue Ridge.
Piedmont.
Midland.
Tidewater.
Ches Bay.
N.W.
Level of Sea.
S.E.
Relief Section, Showing Grand Divisions of Va.
SCALE.
50
100 MILES.
By Jed. Hotchkiss.
Staunton, Va.
1885.
Potomac R.
BALTIMORE.
Winchester
WASHINGTON
Alexandria
Fredericksburg
Rappahannock R.
Staunton
Charlottesville
RICHMOND.
West Point.
James R.
York R.
Chesapeake Bay.
Cape Charles City.
Newport News.
Norfolk.
Lynchburg
Roanoke
Burkeville
Petersburg
New River
Bristol
Danville
Roanoke R.
Weldon.
Chesapeake & Ohio R.R.
Kanawha R.
Pocahontas
Clinch R.
Holston R.

Many of the deposits opened in this State exhibit in a marked degree the uncertainties and risks of manganese mining heretofore pointed out, as well as the misleading character of "indications." Deposits that have promised remarkable results, as well as large returns to their owners, have proven in many cases to be pockets of small extent, producing at most before exhaustion but a few hundred tons of ore, and baffling all attempts to discover additional ore in their vicinity. In other deposits the ore will prove high in phosphorus or low in manganese, or so irregular in its content of mineral as to make selection difficult or uncertain, and to forbid giving the guarantee of richness, and for some uses of the purity, which purchasers require. For obvious reasons, therefore, it has not been possible in every case to ascertain the exact facts as to the character or the present condition of the deposits discussed. The statements made must be regarded as giving the best information available. They are also made "on authority," and are in but very few cases the results of the personal examination of the agents of the Geological Survey.

### TIDEWATER, VIRGINIA.

Some manganese has been found in pockets of small extent in the Tidewater sections of Virginia. One deposit near City Point yielded before it was exhausted some hundreds of tons of ore, and it is reported that others have been worked. No deposits of such extent as that at Crimora can be expected in this region, though it is probable that small pockets will be found in connection with the beds of iron ore that outcrop in the bluffs along the banks of the rivers. The age of these deposits is much later than that of those found resting on the Potsdam in the Valley, the iron ore with which it is associated being found in the Tertiary, chiefly in the Miocene.

### MIDLAND, VIRGINIA.

In the Midland district of Virginia deposits of manganese become more abundant, this division, with the valley, furnishing practically all the manganese mined in the State in 1885. This region has also, in this and previous years, produced considerable quantities of ore for export, The ore that has been mined is found chiefly in Campbell, Nelson, and Pittsylvania counties, though there are deposits in Spottsylvania, Louisa, Appomattox, and perhaps other counties. The deposits are found in the extreme western part of the section, well up to the base of the mountains that form the dividing line between this and Piedmont; indeed it is possible that some of these deposits should be classed in Piedmont, but as they are all situated on the same belt as Campbell county they are classed in Midland.

Finding its source in the heart of the Alleghenies, the James river runs parallel to their base in a southeasterly direction for some distance, breaking through their most easterly spur at the magnificent pass of

Balcony Falls, and still pursuing its generally southeasterly direction until it strikes Mount Athos, some 6 miles below Lynchburg, where it turns abruptly to the northeast, being deflected by the massive quartzites which carry the mountain. It runs in this general direction for some 50 miles to Scottsville, where it resumes its southeasterly direction to Richmond.

It is in the belt of country lying along the left bank of the James and in its extension to the southwest from Mount Athos, that the manganese ores of this section are chiefly found. Along this entire distance the iron-ore bearing rocks have been traced, in connection with which the manganese is found. The northwestern boundary of these rocks is the Buffalo Ridge and its extensions. The southeasterly boundary has not been determined; sufficient has been learned, however, to indicate that the rocks have a width of several miles, and that they extend through the State in a southwesterly direction.

Describing this region, Dr. J. P. Kimball, the present Director of the Mint, says:

"The iron ores of the James river belt are in the form of bedded veins occupying regular horizons which are remarkably well defined. They are interposed between strata of different characteristics, which are practically parallel throughout the belt. They are therefore distinctly traced and recognized. These include quartzites, sandstones, damourite, and other talcose schists, chloritic schists, and talcose (micaceous) limestone, forming a series of strata over 1,500 feet in thickness (1,500 to 3,000 feet), but by frequent plication they have been folded sharply upon themselves so as to constitute a belt several miles across (from 6 to 8) at the surface."

*Campbell county.*—The manganese deposit most extensively worked in this region at the present time is near Mount Athos, in Campbell county. Next to the Crimora mine this Mount Athos mine yielded the largest amount of high-grade manganese of any mine in the country. It is situated just across the line from Appomattox county, near Mount Athos station on the Norfolk and Western railroad, just where the James river turns to the north. It is one of the few deposits on the right bank of the James. This mine is sometimes known as the Leets mine, and has been worked recently by Mr. Logan.

During the past six years the production of this mine was as follows:

*Production of the Leets mine, Virginia, for six years,* 1880 *to* 1885.

| Years. | Long tons. | Years. | Long tons. |
|---|---|---|---|
| 1880 | 104 | 1883 | 40 |
| 1881 | 50 | 1884 | 76 |
| 1882 | 130 | 1885 | 500 |

The manganese is found in pockets associated with iron ore, and also as button ore in a dark-colored micaceous schist, 8 feet thick, holding some 40 per cent. of nodules, varying in size from a bean to that of an oyster. Analyses of this ore are as below:

*Analyses of Mount Athos, Virginia, manganese ores.*

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Metallic manganese | 43.58 | 45.87 | 44.18 |
| Metallic iron | 5.24 | 5.34 | 6.64 |
| Phosphorus | .316 | .257 | .274 |
| Silica | 7.15 | 7.77 | 7.73 |

Some of the ore is much better than these analyses, showing 48 to 50 per cent. metallic manganese. Most of the ore is shipped to England for chemical purposes.

At Bishop's mine, Lynch's station, on the Virginia Midland railroad, 13 tons of manganese were mined and shipped to England in 1885 by the same party that worked the Mount Athos mine. This deposit seems to be a continuation of the Mount Athos, and is of the same general character and quality of ore.

A small pocket yielding some 30 tons was opened at Leesville, near Lynch's station, in 1883.

*Pittsylvania county.*—Southwest of the Mount Athos deposit on the Staunton river, in Pittsylvania county, is a deposit of manganiferous iron ore, yielding the following analyses.

*Analyses of manganiferous iron ore from Pittsylvania county, Virginia.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 24.78 | 27.86 |
| Metallic iron | 29.86 | 28.14 |
| Phosphorus | .362 | .347 |
| Silica | 7.02 | 4.32 |

The deposit is but a quarter of a mile distant from the Virginia Midland railroad.

*Appomattox county.*—To the north of Campbell county lies Appomattox. Deposits of good manganese are reported to exist in this county, but no details have been secured.

*Amherst county.*—Westward of Appomattox county and north of Campbell is Amherst county. At Stapleton Mills, in this county, a manganiferous iron ore with 54.669 per cent. manganous oxide (34.56 metallic manganese), 22.57 metallic iron, and as little as .08 per cent. of phosphorus is found, though it has been mined only to a limited extent, if at all. At Walker's Ford station, in Amherst county, another deposit is reported.

*Nelson county.*—In Nelson county several deposits of manganese have been worked quite extensively in past years, though no ore is now mined. These deposits are found in the ore belt of the James river already described, the belt running nearly parallel to the river, and about 2 miles from the left or northwestern bank. The manganese shows generally in small quantities on the surface, the deposit widening as it goes down. The manganese is found in pockets and usually in clay.

From what is known as the Cabell mine, two miles from Warminster depot, on the Richmond and Alleghany railroad, some 5,000 tons of manganese were taken in 1868 and 1869, and shipped to Newcastle-on-Tyne. The mine has not been worked since 1871. An analysis of the ore showed 82.25 per cent. of maganese peroxide.

Two other analyses gave the following:

*Analyses of maganese ores from Cabell mine, Virginia.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 44.30 | 43.02 |
| Metallic iron | 3.67 | 4.24 |
| Phosphorus | .243 | .182 |
| Silica | 17.45 | 18.51 |

About half a mile southwest of the Cabell mine is a deposit known as the Bugley mine, which was worked about the same time and yielded about 2,000 tons of ore.

At Midway Mills is a deposit on the land of Mr. G. F. Simpson, which was worked in 1882, and yielded some 1,200 tons of first-class ore. The mine was worked by shaft to the depth of 165 feet, when it was drowned out. The ore above the water line is said to have shown some 70 per cent. oxide, but below the line it was much richer, 80 to 85 per cent. The entire product was marketed in Liverpool.

At the Davis mine, in Nelson county, an ore giving from a picked specimen the following analysis was at one time mined, though operations are now suspended:

*Analysis of manganese ore from Nelson county, Virginia.*

| | Per cent. |
|---|---|
| Manganese binoxide | 90.42 |
| Iron sesquioxide | 2.24 |
| Alumina | 1.13 |
| Lime | 1.22 |
| Magnesia | 2.28 |
| Silica | 1.12 |
| Phosphoric acid | .43 |
| Water | 1.25 |
| Metallic manganese | 57.16 |
| Metallic iron | 1.56 |
| Phosphorus | .188 |

Some 1,000 tons have been taken from this mine, though none in the last year.

No details have been obtained concerning the Piedmont and Blue Ridge districts.

### THE VALLEY OF VIRGINIA.

The chief sources of the manganese produced in this State and in the country are the mines of the Valley of Virginia, or, as it is sometimes called, the Shenandoah Valley. In this valley are located the Crimora mines, that have produced as much ore as the entire country besides, those of the Blue Ridge Ore Company and the Shenandoah Iron Company. The manganiferous belt lies along the western base of the Blue Ridge on the eastern side of the valley. It is asserted that this belt extends 300 miles in the State, and that workable beds of manganese ore have been found in every one of the twelve valley counties that abut on the western foot of the Blue Ridge.

It is along this belt that the remarkable body of iron ore accompanying the Potsdam, or No. 1 formation of Rogers, is found, and with this iron the manganese ores are associated. Indeed, it is in the clays formed by the decomposition of the ferriferous shales of the Potsdam that the ore is usually found imbedded. An exception to this is noted by Prof. Wm. M. Fontaine in his "Notes on the Mineral Resources at Certain Localities in the Western Part of the Blue Ridge," as occurring on the lands of Joshua Robertson, some 5 miles from Waynesborough. The ore at this point, which is psilomelane, occurs in the Primordial formation in a fissure in a cracked and crushed band of the upper gray shales and flags, and has impregnated the walls, which are kaolin flags. Some 100 tons were taken from this locality in 1857 by a Mr. Sibert. Professor Fontaine is of the opinon that the origin of this manganese is similar to that of the iron ore occupying a similar geological position, viz: deposition in disturbed beds from solution in water.

*Page county.*—Passing southwardly down the valley, along the line of the Shenandoah Valley railroad, the first deposit that produced any considerable quantity of the ores of manganese in 1885 is found in Page county, near Milnes station, on the lands of the Shenandoah Iron Company. From these mines there were shipped in 1884, 208 tons of manganiferous ores, and 2,155 tons in 1885. The average of analyses of the deliveries was about as follows:

*Analysis of manganiferous ores from Page county, Virginia.*

| | Per cent. |
|---|---|
| Metallic manganese | 28. |
| Metallic iron | 17. |
| Phosphorus | .15 |

This ore was mined in a wash or drift deposit associated with brown hematite. The deposit is quite irregular and uncertain. This range of ore lies along the eastern foot of the Blue Ridge, and evidently contributed to the Crimora basin, which is in this range.

From a deposit on what is known as the Garrison tract, the top of which is a fine ore, but which becomes coarser and harder as it goes down, Mr. A. S. McCreath took samples which gave the following analyses:

*Analyses of manganese ores from the Garrison tract.*

| | Fine ore. | Lump ore. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 52.691 | 53.656 |
| Metallic iron | 2.325 | 1.537 |
| Phosphorus | .324 | .327 |
| Silica | 27.95 | 1.955 |

A manganiferous iron ore is found in the Kimball bank, lying 3 miles east from Milnes station. This bank consists of two openings, the Atwood and Bolan, the Atwood carrying the larger proportion of manganese. A sample of these ores mixed (two-thirds Atwood and one-third Bolan) showed the following analyses:

*Analysis of manganese ore from Kimball bank.*

| | Per cent. |
|---|---|
| Metallic iron | 40.875 |
| Metallic manganese | 7.349 |
| Phosphorus | .084 |
| Siliceous matter | 15.440 |

Another analysis of the ore by Bowron gives—

| | Per cent. |
|---|---|
| Sesquioxide of iron | 70 |
| Manganese oxide | 13.31 |
| Silica | 4.73 |
| Alumina | .86 |
| Water | 11.02 |
| Phosphorus | Mere trace. |

*The Crimora mines.*—The most important mine in this region, and indeed, in the United States, is that of the Virginia Manganese Company, now operated under lease by the American Manganese Company, limited. The ore from this mine was at one time known as the Waynesboro' ore, from its point of shipment on the Chesapeake and Ohio railroad. This mine is in Augusta county, 2½ miles east from Crimora station on the Shenandoah Valley railroad, with which it is connected by a branch-road, and 8 miles northeast from Waynesboro'. A post-office called Mushet has recently been established at the mine. The distance to

tidewater at Baltimore is 217 miles, 194 to Newport News, and 209 to Norfolk. To Pittsburgh the distance is 354 miles. The history of this mine and a most complete analysis of the ore is given in the report for 1883–'84. The production brought down to the close of 1885 is as below.

*Production of the Crimora mine, Virginia.*

| | Quantity. |
|---|---|
| | *Long tons.* |
| Prior to 1869 | 5,684 |
| May, 1869, to February, 1876 | 280 |
| February, 1876, to December, 1878 | 2,326 |
| December, 1878, to December, 1879 | 1,602 |
| 1880 | 2,963 |
| 1881 | 2,495 |
| 1882 | 1,652 |
| 1883 | 5,185 |
| 1884 | 8,804 |
| 1885 | 18,212 |

The ore deposit, which is most peculiar in its location and accumulation, occurs in an elliptical basin about 500 feet broad on its transverse axis, and 800 to 900 feet long. This basin is cut out of the Potsdam sandstone, which is at this place hard rock. Opposite to the basin and at a right angle to its longer axis is a deep ravine, Turk's Gap, sharply cut into the flanks of the mountain, through which a stream flows. Nearly opposite to this ravine is a ridge that served as a bulwark to the action of the forces at work in this section. Evidently this basin is the work of old time eroding agencies acting just as water now acts below a river dam excavating a deep curved section. The formation and location of this basin, as well as the deposit it contains, is exceedingly interesting and peculiar.

The basin is filled with wash and manganese ore lumps. The general body mixture, the mud, sand, and clay, with the lumps of manganese ore, were carried to place by agencies more recent than those which excavated the basin, just as the iron ore pits in the limestone valleys of Pennsylvania were filled in.

There are two, possibly three, special layers of clay, which are rich in lumps and masses of ore, the lower about 30 feet in thickness, the upper about 25 feet thick. A layer of clay, 20 feet thick, almost barren of manganese ore, separates these two ore-bearing layers. The mining operations are at present confined to these beds.

The ore is found in lumps and masses from the size of a small pebble to lumps weighing a quarter of a ton or more. These lumps are found scattered through the basin as above indicated. The basin at the shaft is 117 feet deep. Some "sheets" of ore formed by the union of masses that lie in a pretty uniform direction are also found. The larger masses when found are blasted in the mine. The smaller pieces, to which the clay adheres quite tenaciously, are washed outside the mine and selections made for the home and foreign markets. A bore hole 285 feet

deep has been put down into the sandstone under the mine to secure water for washing. The question of washing the whole contents of the basin on the principle of the hydraulic mining of the gold regions of California has been mooted, and it is quite probable that a large portion of the deposit can thus be treated with profit. At present the dirt covering the mines is being stripped down to the ore deposit and mining at these points will be by open cut.

The older workings on this property were by open pits, and most of the manganese obtained was probably float. The present workings are by shaft, and the ore is found in its original position. The rooms and ways leading from the shaft require heavy timbering, as the clay which forms the ore matrix when acted upon by moist air softens and makes this a very muddy mine in all its parts. There is also some liability to flooding, arising from heavy rains, and the peculiar conformation of the country about the mine.

The quantity of manganese ore in this basin is difficult to estimate, owing to the somewhat irregular distribution of the ore lumps through the mass.

An analysis of the best quality of the ore by Mr. A. S. McCreath shows:

*Analysis of manganese ore from Crimora, Virginia.*

| | Per cent. |
|---|---|
| Metallic manganese | 57.291 |
| Metallic iron | .373 |
| Phosphorus | .075 |

A second quality would show a reduced percentage of metallic manganese, but on the whole the quality is moderately uniform throughout. The ore is a psilomelane. Occasionally some pyrolusite is found, forming thin veins or nests in the lumps of psilomelane.

The manganese ore probably comes from the decomposition of the lower members of the Auroral limestone (II) of the Shenandoah Valley, possibly from the ferriferous shales, the position of which is somewhat in doubt, it being a question whether they should be regarded as the highest member of the Potsdam or the lowest of the Auroral. The masses are evidently concretionary in their origin, and derived from the manganese diffused through the shales, probably in the form of a carbonate. These masses are not only inclosed in clay which folds around them, but they often inclose clay. The clays in the horizon of the ferriferous shales are colored brown from the diffused manganese, while the clays of the deposit in which the manganese is most abundant are red, showing that the gathering of the manganese into masses has left the iron predominant. Lime was probably the agent in the deposition of the manganese. The process of the concretion of the manganese is still going on at localities in this valley, and partially formed crust and nodules are found.

*Other mines in Augusta county.*—Quite recently an organization known as the Old Dominion Manganese Company has been formed, with a capital of $50,000, for the purpose of seeking manganese on the lands adjoining those of the Crimora mines. These consist of three tracts containing 543 acres, 348 of which are held in fee, and 195 on a perpetual lease at 50 cents a ton royalty. The company is putting down a shaft on the Patrick tract just across the line and some 100 yards from the shaft of the American Manganese Company, limited. The course of the tunneling of the latter from the bottom of its shaft and the results obtained, lead the Old Dominion Company to the belief that the Crimora deposit will be found to extend to its land. Some 80 or 90 tons of "float" manganese ore of a good quality were mined in open pits on the Patrick tract during the time when the Crimora mines were worked by Mr. Donald, and during the present year surface specimens have been found on the same tract.

Seven miles south of Waynesboro', and 2 miles southeast of Lyndhurst station on the Shenandoah Valley railroad, the Virginia Manganese Mining Company is opening up some old mines and making preparations to ship their product. The deposit lies in Augusta county, 14 miles southwest from the Crimora mines, well up to the western base of the Blue Ridge on a little stream known as Bear creek, 2½ miles above its junction with South river. This creek flows in the clay formed by the decomposition of the ferriferous shales in the Potsdam.

This deposit was opened in 1859 by Mr. Sibert, who opened a number of mines in this valley about this time. He sunk a shaft striking the ore deposit at the depth of 45 feet. From the bottom of the shaft a drift was driven some 20 feet. Upwards of 250 tons of ore were taken from the shaft and drift and shipped to London. Analyses of the ore recently taken from this shaft are as follows (J. Blodgett Britton, chemist):

*Analyses of manganese ore from Heiserman's farm, Augusta county, Virginia.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Peroxide of manganese | 93.06 | 86.77 |
| Peroxide of iron | Trace. | 2.98 |
| Silica | .18 | 3.98 |
| Alumina | .91 | 2.81 |
| Baryta | 2.81 | .31 |
| Water (total) | 2.75 | 2 93 |
| Lime | ..... | Trace. |
| Not determined and loss | .29 | .22 |
| Total | 100.00 | 100.00 |
| Available peroxide | 92.54 | 86.62 |

The old shaft was destroyed and filled up by a flood, a very common occurrence apparently in this section. The new shaft is located above

the flood level. It is expected that it will be down to the ore early in 1886.*b*

Adjoining the lands of the Virginia Mining Company just referred to on land formerly owned by a Mr. Wagner, now the property of the American Manganese Company, limited, a most interesting deposit of manganese occurs. Professor Fontaine states that on this tract he observed manganese in process of formation into lumps. He says: "On Mr. Wagner's place, in the bed of the creek, there is an interesting exposure of the clay, showing the manganese in process of formation by concretionary action. Here, as usual, the ore is mainly psilomelane, or hard manganese, but in this place the masses have some pyrolusite and manganite, the softer varieties of manganese oxide in the cavities of the material or forming seams of harder ore. Lumps and crusts of the manganese may be seen imbedded in the clay, and they are plainly now in process of formation. The manganese seems to be freely diffused through the dark brown umber and to be gradually concentrated out of the clay in lumps and crusts. In some cases crusts of manganese may be seen inclosing the clay, and the nodules often show inclosed clay."

Another of the manganese ore deposits opened before the war by Mr. Sibert is known locally as the Kennedy tract, lying 3 miles from Stuart's Draft station on the Shenandoah Valley railroad. It takes its name from the old Kennedy furnace built early in the present century, and adjoins the lands of the more recent Mount Torrey furnace. Mr. Sibert is reported to have mined some 100 tons of the ore in 1859. In 1872 a Mr. Armstead dug some pits searching for iron ore, and is reported to have discovered at a depth of 20 feet a bed of psilomelane. Ore taken from this opening shows from 30.52 to 43.30 per cent. of manganese.

A complete analysis is as follows:

*Analysis of manganese ore from Kennedy tract.*

| | Per cent. |
|---|---|
| Metallic manganese | 43.30 |
| Metallic iron | 3.88 |
| Sulphur | .083 |
| Phosphorus | .052 |
| Barium | 6.93 |

The ores occur both as manganese ores and as manganiferous iron ores. At one point it is in bands and films one-fourth of an inch in

*b* Since the above was written, under date of March 15, 1886, Mr. M. P. O'Hern, the president of the company, writes me: "I have completed my shaft down to 65 feet, and have struck a solid body of manganese of the finest quality, all crystallized. The deposit is very extensive; is estimated to be over 20 feet deep. * * * The test of this ore is fully equal to my expectation, assaying from86.77 to 93 per cent. free from iron and other deleterious matters."

thickness, the ore being nodular in form and inclosed in clay from the ferriferous shales.

At Blue bank, at the "Fauber mines," at Newton's mine bank, at the Kelly bank, and several banks on the Big Mary creek, all in the neighborhood of the old Cotopaxi and Vesuvius furnaces, which have been abandoned for some years, manganese and manganiferous iron ores have been found and mined to some extent. These deposits are all near the line of the Shenandoah Valley railroad, and near the line separating Augusta and Rockbridge counties. The Blue bank was opened to supply the Cotopaxi furnace, but it had too much manganese in it to be used as an iron ore, and the working was abandoned. The Fauber mines were opened by Mr. Sibert, who took from them some 75 tons of manganese, it is said. The deposit is psilomelane in nodular masses and lumps in clay. Newton's mine bank is in a steep ridge near the headwaters of the south James river. Sometimes the ore from this mine is a quite pure oxide of manganese, and again only a manganiferous iron ore. The deposit is quite large, a section showing one of the two veins to be 36 feet wide, composed of alternate deposits of hematites, mixed iron, and manganese, and manganiferous iron ore. An analysis of a sample of the ore, one hundred and forty-three pieces, taken from along the face of the open cut, made by Mr. McCreath, shows:

*Analysis of manganese ore from Newton's mine bank.*

| | Per cent. |
|---|---|
| Metallic iron | 41.125 |
| Metallic manganese | 8.221 |
| Phosphorus | .265 |
| Silicious matter | 14.830 |

The Kelly bank is part of the property of the old Vesuvius furnace, and is situated in Rockbridge county. Both iron ores and manganiferous ores are found, the latter lying nearer the Potsdam than the former. Much of the ore consists of iron and manganese mixed, the manganese forming layers and films in the iron. On Big Mary creek manganese has been found at several openings, and surface indications of other deposits are abundant. Here the same conditions exist as at the Kelly bank, some of the manganese being quite pure and some mixed with iron. The richest manganese shows some 47 per cent. of the metal to 6 per cent. of iron.

*Botetourt county.*—A mine in the Valley of Virginia, the Crimora, not only yielded the largest amount of manganese ore produced by one mine in 1885, but another mine in the same valley, the Houston, has produced the largest amount of manganiferous iron ore. Some of this ore much exceeds the 44.252 per cent. of manganese that we have taken as the dividing line between manganese ore and manganiferous iron ores, and should therefore be classed as manganese ores; but as the average

of shipments is less than this standard, it is classed as manganiferous iron ore, though included in the total of ore produced.

This deposit is near Houston station, on the Shenandoah Valley railroad, on the property of Mr. Ed. S. Hutter and the heirs of Langhorne; the mines are at present worked by the Blue Ridge Ore Company, of which Mr. Ed. S. Hutter is superintendent. The ore comes from what is known as No. 4 opening, which lies 1¼ miles from the station. The bank is developed by open cut and tunnel, the cut being 75 feet long, 30 feet wide, and 50 feet deep. The ore is highly manganiferous and at points is quite pure. It occurs in pockets next to iron ore, and examination indicates that the deposit is a large one. About two-thirds of the ore is lump, the rest is quite fine. Preparations are now being made to sink a shaft and put up hoisting machinery. A selection of one hundred and fifteen pieces to represent the iron ore, and sixty-eight pieces to represent the manganese, gave Mr. McCreath, upon analysis, the following results:

*Analysis.*

| | Iron ore. | Manganese ore. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 7.277 | 44.312 |
| Metallic iron | 47.150 | 12.325 |
| Phosphorus | .061 | .101 |
| Siliceous matter | 8.030 | 5.470 |

*Analysis of a sample of selected ore.*

| | Per cent. |
|---|---|
| Metallic manganese | 59.870 |
| Metallic iron | .500 |
| Phosphorus | .049 |
| Silica | 2.300 |

There have been 4,810 long tons of ore taken from this mine, divided as follows:

*Product of ore.*

| | Long tons. |
|---|---|
| 1883 | 2,900 |
| 1884 | 828 |
| 1885 | 1,082 |

The production of 1883 was shipped to the Cambria Iron Company, Johnstown, Pennsylvania; that for 1884 and 1885 to the Edgar Thomson Steel Works, Pittsburgh.

*Average analysis of the monthly shipments for* 1884 *and* 1885.

| | Per cent. |
|---|---|
| Metallic manganese | 39.00 |
| Metallic iron | 12.00 |

The highest monthly average was 45 per cent. metallic manganese; lowest, 31 per cent; phosphorus, about 0.07 per cent.

The manganese deposits at this mine lie well up on the west slope of the Blue Ridge range. No. 4, referred to, is situated on the northwest slope, and just at the foot of a branch ridge separated by a narrow valley, not over 50 feet wide, from another ridge, which lies to the west, and parallel with the ridge in which No. 4 is found. This No. 4 opening is about 1,250 feet above tidewater at Richmond; 400 feet above the drainage level of the surrounding country. The deposits of manganese appear from end to end of the tract, which is worked for two-thirds of a mile in length. The ore line runs northeast to southwest, 35 north of east. The manganese occurs in pockets, usually in a tough yellow clay, sometimes next to a fine red sand; occasionally nest or pockets of the purest manganese are found, yielding 100 to 150 tons of ore in lumps the size of an egg and smaller, and so clean as to require no washing. A drift has been run into the deposit, intersecting it some 100 feet below the slope on the ridge, and some 45 feet below the lowest ground in the valley. It appears to increase in size, and improve in quality the deeper it is mined.

At No. 4 opening, the principal pocket of manganese lies just above and against the Potsdam sandstone, which is here massive and hard. Much of this sandstone when blasted and shattered, contains very beautiful specimens of pure manganese adhering most tenaciously to the stone. In mining, however, but little rock has been uncovered as yet, though some 75,000 tons of iron ore and 4,000 tons of manganese have been taken out. The slates or shales are found to the northwest of the ore line and at the base of the foot hills of the Blue Ridge, half a mile from the clays that carry the ore deposits. Adjacent to these, the limestone stretches away to the northwest.

During the year 1886, it is the intention to sink a shaft 100 feet below the lowest drift. This, with other improvements, will permit of a much larger output in 1886 than heretofore.

Southward from the Houston mines, in the same range, Mr. J. T. Chapman has a deposit of manganese, which gave the following:

*Analysis of manganese ore from the Chapman deposit, Botetourt county, Virginia.*

| | Per cent. |
|---|---|
| Metallic manganese | 45.80 |
| Metallic iron | 3.06 |
| Phosphorus | .164 |

*Other Valley deposits.*—Along the base of the mountains that form the continuation of those at whose base the Valley deposits already described are found, numerous openings show the presence of manganese and manganiferous iron ores. This is especially true of the country lying along the line of the Cripple creek extension of the Norfolk and Western railroad. These ores are found on Iron mountain on the east, on Lick and Draper mountains in the center, and on Big Walker's mountain on the west side of the Valley.

Four miles east from Radford furnace in Pulaski county, on the east face of a ridge on Mack's mountain, is a deposit of rich dark brown hematite, with associated manganese. Some large lumps of quite pure ore have been found. One hundred and thirty-two pieces as samples were taken from the outcrop by Mr. McCreath, which yielded as follows:

*Analysis of manganese ore from Pulaski county, Virginia.*

| | Per cent. |
|---|---|
| Metallic iron | 39.975 |
| Metallic manganese | 14.785 |
| Phosphorus | 1.074 |
| Siliceous matter | 5.840 |

The Walton furnace of the Lobdell Car-wheel Company, situated in Wythe county, has used as part of its burden an ore from what is known as the Glade manganiferous ore bank, 4 miles southwest from Max Meadows, which is chiefly a brown hematite, but at times highly charged with manganese. An analysis of a large number of samples gave the following result:

*Analysis of manganese ore from the Walton furnace, Wythe county, Virginia.*

| | Per cent. |
|---|---|
| Metallic manganese | 4.971 |
| Metallic iron | 50.450 |
| Phosphorus | .444 |
| Siliceous matter | 5.440 |

At Noble furnace, in the same county (Wythe), is a bank of ore with the same characteristics, mixed hematites and manganese. An analysis of specimens of this ore gave the following result:

*Analysis of manganese ore from Noble furnace, Wythe county, Virginia.*

| | Per cent. |
|---|---|
| Metallic manganese | 3 155 |
| Metallic iron | 49.050 |
| Phosphorus | .179 |
| Siliceous matter | 10.770 |

In Smythe county, at what is known as the Razor bank, on the south fork of the Holston river, in Rye valley, the ore shows at times considerable manganese. Mr. McCreath's analysis of a sample of one hundred and thirty-three pieces gave:

*Analysis of manganese ore from the Razor bank, Smythe county, Virginia.*

| | Per cent. |
|---|---|
| Metallic manganese | 10.181 |
| Metallic iron | 40.100 |
| Phosphorus | .536 |
| Siliceous matter | 10.520 |

Some 6 miles from Seven Mile Ford station, on the Norfolk and Western railroad, on what is locally known as Chestnut ridge, several openings have been made, showing a rich grade of manganese ore, from which some ore has been taken for trial.

Near Marion, Smythe county, on the east flank of Glade mountain, is a large deposit of manganese, associated with a good brown hematite, which is found in large masses in this region. The deposit has been traced for 8 miles along the outcrop. Large bowlders of the manganese are found, some weighing over half a ton.

The following analysis shows the character of the ore:

*Analysis of manganese ore from near Marion, Smythe county, Virginia.*

| | Per cent. |
|---|---|
| Metallic manganese | 9.91 |
| Metallic iron | 45.32 |
| Phosphorus | .086 |
| Silica | 1.76 |

*Oriskany ores.*—Some of the manganese ores in Pulaski and Wythe counties are found in the Oriskany rocks, the lower member of the Devonian, as the Potsdam, in connection with which so much manganese is found in this valley, is the lower member of the Silurian. The Oriskany ores in this section are usually of a much higher grade than the ores of the Potsdam in the same region. The ores are at times brown hematites of a high grade, at others manganese, and at still others, nothing but a ferruginous sandstone.

### APALACHIAN VIRGINIA.

In that portion of Virginia known as Apalachia, which includes the broken mountainous country between the Valley and West Virginia, quite a number of deposits of manganese ore, some quite high in manganese and of a good quality, are known to exist. Most of these are so situated with reference to transportation routes, however, that they are not available at present.

The manganese ores in this portion of Virginia are, as a rule, of a later geological age than those of the Valley. The Valley ores are usually found in connection with the Potsdam No. I. of Rogers' survey. Those of Apalachia are found in the Hudson River No. III., the Clinton No. V., and especially in the Oriskany No. VII. In all cases the manganese is associated with iron ores, usually brown hematites, sometimes as a manganiferous portion of an iron ore, at others as a manganese ore.

Little or no ore was mined in Apalachia in 1885, but preparations are being made to open up several of the known deposits during 1886. Possibly some manganese has already been shipped from the Powell's Fort and the Goshen Bridge mines.

*Frederick county.*—In the southwest corner of Frederick county is a deposit of manganese known as the Paddy Mills manganese mine, which has produced some manganese in past years. The mine is a conical shaped hill, covering about a square mile, and rising to a height of some 150 feet above the drainage level of the surrounding country. The ore is found in connection with the limestone, and imbedded in the strata. The deposit is somewhat unreliable, being cut off by the limestone. The ore is chiefly soft pyrolusite; part of it, however, is hard, running about 50 per cent. metallic manganese, 4 per cent. iron, and from .09 per cent. to 0.1 per cent. of phosphorus. There have been removed from this mine some 2,000 tons of ore, mostly before the war, and by very imperfect methods of mining. No shaft has gone below 50 feet, so that it is not known how large the deposit is. Should it extend downwards, considerable ore might be found. The ore requires washing, for which there is plenty of water.

*Shenandoah county.*—At Van Buren furnace, in Shenandoah county, in connection with the iron ores, a valuable and extensive deposit of manganese is found. This was at one time worked extensively, very large amounts being shipped before the war, but no mining has been done for twelve years, owing to the lack of transportation facilities, there being no railroad station nearer than Woodstock, 9 miles distant. The ore occurs in pockets, but they seem to be continuous, and can be traced on the surface for more than 3 miles. The washed ore analyzes upwards of 70 per cent. oxide. In a description of the Van Buren furnace property, on which this deposit is located, Maj. Jed. Hotchkiss makes the following statement regarding manganese:

"Manganese has been mined in considerable quantities from the mine located at the western end of Cupola mountain, where, as is very often the case in Virginia, it accompanies the outcrop of No. VII. (Oriskany), the backbone of that mountain. It outcrops also in the broken hills that prolong Cupola to the southwest; it also shows in places along the iron-ore outcrops of Tea, Little North, and the eastern slopes of Paddy mountains, where, no doubt, large pockets of this valuable mineral will be found in the stratified iron ore beds, locally taking the place of the iron ore, as is often the case in the Clinton beds in Virginia,

There is no doubt but that this mineral will be mined here in large quantities when the price paid for it will warrant mining and hauling it to the railway, or whenever a railway reaches this place."

A company has been organized and a charter secured to build a railroad to this property and beyond. The pig iron made at the furnace on this property, which is an excellent car-wheel iron, shows from 0.36 per cent. to 1.735 per cent. of manganese.

Considerable attention has recently been directed to what is known as the Powell's Fort manganese mines, located at Powell's Fort, in Shenandoah county, on the Northeast Massanutton mountain. This mine has been worked at times for many years. The property is owned by the Manganese and Iron Company of Baltimore, and contains 531 acres immediately between Three Top mountain to the north and Green mountain to the south. This system runs northeast and southwest, conformably with the universal belt of the Apalachian chain. The following statement is furnished by the company:

"There are two parallel veins, over one mile in length; only one of which, however, is developed. The mines have been operated at intervals for several years in a crude manner and on a very small scale. During this time considerably over 1,000 tons of ore were shipped. One of the most celebrated manganese experts in the United States carefully examined this property and advised its purchase by the company, as it was the only well-defined vein he had ever seen—the walls perfectly regular, the hanging conglomerate, the foot-wall sandstone. The vein varied in width from 4 to 7 feet, traceable from one boundary of the property to the other by its bold outcrop, which has been opened at several places, showing well everywhere. At present there are two shafts, respectively, 85 and 75 feet deep, with level over 40 feet long through solid ore. The engine shaft will be sunk to the depth of 200 feet.

The ore is remarkably clean; almost entirely free from foreign matter. It is highly crystallized, very soft, a genuine pyrolusite of high grade, and is nearer chemically pure than any yet found, as will be seen by reference to the accompanying analyses.

It has not only been used in the manufacture of Bessemer steel, but in the arts, and for electrical purposes it is highly satisfactory. A small lot sent to Glasgow was highly commended.

The company has only been in possession six months, during which time new buildings, boilers, engine, hoisting apparatus, pumps, etc., have been placed upon the property, and the mines thoroughly equipped for the economical and expeditious raising and handling of large quantities of the ore.

A line for a railroad, nine miles in length, has been surveyed by the Midland Railroad Company, and will, most likely, be constructed immediately."

*Analysis of manganese ore from Powell's Fort, Shenandoah county, Virginia (Manganese and Iron Company).*

[By J. Blodgett Britton, of Philadelphia.]

| | Per cent. |
|---|---|
| Oxide of manganese (*a*) | 94.30 |
| Moisture | .28 |
| Insoluble siliceous matter | 1.78 |
| Alumina | 1.10 |
| Baryta | 1.30 |
| Sesquioxide of iron, lime, and manganese | .50 |
| Undetermined matter | .74 |
| Total | 100.00 |

*a* **Nearly all binoxide.** By the analysis it should be taken as a fully 90 per cent. binoxide.

[By J. Blodgett Britton.]

| | Per cent. |
|---|---|
| Silica in the form of quartz | 3.78 |
| Peroxide of iron | .43 |
| Metallic manganese | 60.66 |
| Oxygen with manganese, undetermined matter and loss | 34.09 |
| Alumina | .25 |
| Moisture | .37 |
| Baryta | .42 |
| Total | (*b*)100.00 |

*b* **By the analysis it should be taken as a fully 90 per cent. binoxide.**

*Analysis of a small sample made at the laboratory of the Albany and Rensselaer Iron and Steel Company, Troy, New York, May 16, 1885.*

**[The sample was from the mine of the Manganese and Iron Company's property.]**

| | Per cent. |
|---|---|
| Iron | 0.844 |
| Phosphorus | .190 |
| Manganese | 59.302 |
| Silica | 1.500 |

*Rockbridge county.*—On what is known as the Guy's Run estate, in Rockbridge county, six miles southward from Goshen Bridge station, on the Chesapeake and Ohio railroad, quite an extensive deposit of manganese has been discovered. Up to the present time but a few tons have been mined, but extensive working is contemplated for the present year.

In its general topography this estate is quite mountainous. The ores are found in the valleys, and can be transported by well-graded roads to Goshen Bridge for $2 a ton. Four openings have been made, the ore being found in each. One of these is but three miles from the Chesapeake and Ohio railroad. The manganese lies in close proximity to Rogers's No. VII. (Oriskany) brown hematite ores, imbedded in potters' clay, which separates it from the iron ore. It is in pockets more or less persistent along the line of the ore horizon of No. VII.

*Analysis of samples of solid ore from Guy's Run estate, Rockbridge County, Virginia.*

| | Per cent. |
|---|---|
| $Mn_3O_4$ | 89.67 |
| $Fe_2O_3$ | 4.30 |
| Sulphuric acid | 1.25 |
| Silicic acid | .79 |
| Metallic manganese | 64.59 |
| Metallic iron | 3.01 |
| Phosphorus | .55 |

There is the best of evidence that there is a large body of ore on this property.

*Other counties.*—In the counties of Apalachia southward of those already named many outcrops and other indications of manganese are found. Most of these are now too far from railways to be profitably worked.

At Panther Gap some ore has been mined, though no statement as to amount or the character of the deposit was obtained.

In Craig county, on Gap mountain, several manganese deposits have been opened, but the distance from railroads precludes shipments, the nearest station being some 20 miles away. These deposits are stated to extend a distance of 17 miles.

Analyses are as follows:

*Analyses of manganese ores from Craig county, Virginia.*

| | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. |
|---|---|---|---|---|---|
| Metallic manganese | 45.00 | 52.42 | 49.48 | 53.06 | 50.50 |
| Metallic iron | | | 6.83 | 1.82 | 4.81 |
| Phosphorus | .085 | .303 | .063 | .058 | .026 |
| Sulphur | | | .010 | | |
| Silica | 4.70 | .46 | 2.53 | 1.67 | .58 |

Nos. 1 and 2 by T. T. Morrell, chemist of the Cambria Iron Company; No. 3 by S. P. Sharpless, Boston; Nos. 4 and 5 by Vulcan Steel Works, Saint Louis.

In Giles county, in the Oriskany measures, the iron ores often give way to manganese. Boyd, in his "Resources of Southwest Virginia," says:

"In one point on these rocks (Oriskany) on Flat Top mountain, near the line between Giles and Bland counties, the ore was found in great purity, containing valuable quantities of manganese disseminated heavily through sandstone." Analysis of this ore shows 59.215 per cent. metallic manganese. Manganese is also found in the Buckeye and Spruce River mountains, and at the ore beds of the Sinking Creek furnace, as well as at other localities in the county.

In Pulaski county, manganese ores of a high grade are found among the Oriskany iron ores of Walker's mountain.

The same is true of the extension of these mountains into Wythe county. The manganese ores found in the Oriskany rocks of Big Walker's mountain, in Wythe county, are at times quite pure.

In Bland county the Oriskany measures in several of the parallel mountain ranges that traverse the country from northeast to southwest, show deposits of manganese ores of considerable extent, and at times quite pure.

In Tazewell county surface indications are quite frequent, but the developments are not as yet sufficient to give an idea as to the extent of the deposits. Some of the specimens indicate rich and valuable ores.

In Smythe county there are frequent indications of manganese. At one, on the property of Mr. William Alexander, near Holstein Mill, the ore is in bowlders varying in weight from 2 pounds to 300. Some 20 tons have been taken out at a depth not exceeding 6 feet. An analysis showed 62.57 per cent. black oxide of manganese.

## GEORGIA.

Second in point of production of manganese in 1885 was the Cartersville or Etowah district of Georgia, though Batesville, Arkansas, fell but little behind, and promises to surpass it greatly in 1886.

*The Cartersville district.*—The Cartersville, or, as it is often called, the Etowah district, is located in the northwestern part of Georgia, in the immediate neighborhood of Cartersville, in Bartow county, the manganese deposits possibly extending into Cherokee county. Cartersville is a station on the Western and Atlantic railroad, 91 miles from Chattanooga and 421 miles from Cincinnati. Tidewater can be reached by rail at Brunswick, 378 miles distant, or at Savannah, 354 miles. The distance to Baltimore is 810 miles. This district was at one time of some importance as an iron-producing section, and at the Diamond furnaces on Stamp creek, near Cartersville, ferro-manganese was first made in the United States, in 1875, by Mr. Willard P. Ward. It is also claimed that this was the first blast furnace ferro-manganese manufacture that was an economic success in any country, the methods of its production at the blast furnaces in Europe prior to this date being extremely wasteful of the manganese in the ore. Mr. Ward produced ferro-manganese containing as high as 67 per cent. of manganese. It is probable that the most successful blast furnace practice in the manufacture of ferro-manganese is still at the furnaces of this country, the Edgar Thomson furnace "A" at Pittsburgh making 7,218 long tons of ferro-manganese and 4,722 tons of spiegel iron in 1885.

In its topography the Cartersville district is broken or knobby, the elevations, however, rarely exceeding 200 feet above the drainage level of the country. The district is quite well watered by the Etowah river and its tributaries, but the manganese deposits opened are so situated as to make it difficult to secure water for washing. The belt of country in which the manganese is found is some 12 miles long by 3 wide. The explorations so far made, however, do not justify any definite conclusions as to the extent of the deposits. It is, of course, understood that

all of this belt is not underlaid with ore. At places the ore is missing; at others it is but a few hundred yards wide.

The ore occurs in pockets imbedded in a drift deposit, usually covering hill tops and outcropping, but at times at a depth of from 3 to 30, and even 100 feet below the surface. These deposits are at times bedded with some regularity, and at others scattered without the least regularity. There are frequently "leads" running from one deposit to another. The drift in which the ore is imbedded varies greatly, being sometimes ocher, at others a blue dirt, soft and without grit, and at still others it is said to be found in sand rock. These deposits have as their base the Silurian rocks, usually the Potsdam, and lie near the metamorphic rocks of the State. They are associated with limonite deposits of a similar character, the limonite usually occurring to the west of the manganese.

The ore occurs as massive, crystallized, and needle ore, and is found in grains from the size of a mustard seed to that of a pea and even a walnut, and also in much larger masses. Until quite recently no attempt was made to recover these smaller grains. Last July Mr. A. P. Silva began mining with a view to saving all the ore, and has secured 1,500 tons from a pit which by the old method would have yielded, say, 300 tons. The ore has not averaged as good a quality as by the old method, nor has it brought as high a price, but it has been much more profitable on the whole, and other miners are now following this method. In these pockets the ore varies greatly, not only in the percentage of ore found in the débris, but in its richness. In the same mines some ore will run as high as 60 per cent. metallic manganese, even higher, and often pieces as low as 38 per cent.

The usual method of mining is by stripping and tunneling. The mining consists in first stripping down the outcrop until there is sufficient height of face to drive tunnels through the deposits. Side tunnels are run from the main tunnels. Little timbering is done.

*Production from the Cartersville region.*—From a gentleman well acquainted with this region, who has had access to the books of the railroad company, the following estimate as to the production of this region since 1866 is given:

*Production of manganese in the Cartersville region, Georgia.*

| Years. | Long tons. | Years. | Long tons. |
|---|---|---|---|
| 1866 | 550 | 1876 | 2,400 |
| 1867 | | 1877 | 2,400 |
| 1868 | | 1878 | 2,400 |
| 1869 | | 1879 | 2,400 |
| 1870 | 5,000 | 1880 | 1,800 |
| 1871 | | 1881 | 1,200 |
| 1872 | | 1882 | 1,000 |
| 1873 | | 1883 | |
| 1874 | 2,400 | 1884 | |
| 1875 | 2,400 | 1885 | 2,580 |

During 1885 the price received from this ore varied from $3.50 to $5.50 at the mines, or from $4.50 to $7.50 on cars. The bulk of the ore was sold at $5 on the cars. The value of the ore was $13,390, or an average of $5.19 per ton.

Most of the ore mined in the earlier years was taken out by the Pyrolusite Mining Company. The last and most productive mine worked by them was the Chumner Hill, located on lot No. 144, Twenty-second district. They also operated the Dobbins mine. Some ore was also taken by this company from the Bishop mine, and the Moccasin ore bank.

*The Dobbins mine.*—The oldest mine now operated in this region, and the one that has produced the most ore, is what is known as the Dobbins mine, now owned by the Bartow Manganese Mining and Manufacturing Company, but operated under lease since the last of November by E. H. Woodward, of New York. Mining began here in 1867, and has been carried on, not continually, however, but for periods of varying length, since that time. Some 5,500 tons have been extracted, the output for 1885 being 500 tons. The ore, as will be seen from the analysis given in the last report, is quite good. It occurs in a pocket, the lead of ore being several hundred yards wide, running due northeast and southwest. The mining operations have been confined to less than an acre of surface. The mine is 4 miles from the railroad station, the cost of hauling to station being $1 per ton.

An analysis of one of the several carloads of ore shipped from this mine to Carnegie Bros. & Co., limited, gave the following results:

*Analysis of manganese ore from Dobbins mine, Cartersville, Georgia.*

| | Per cent. |
|---|---|
| Metallic manganese | 52.726 |
| Metallic iron | 4.490 |
| Silica | 4.300 |
| Phosphorus | .1882 |

*Partial analysis of manganese ore from Dobbins mine.*

| | Per cent. |
|---|---|
| Metallic manganese | 48.832 |
| Metallic iron | 5.40 |
| Silica | 5.05 |

Some ore in this mine yields as high as 87 per cent. of peroxide.

Most of the past year has been spent in opening this mine and placing in position the machinery necessary to mine and clean the ore, in view of a largely increased output during 1886.

*The Etowah mines.*—The largest producer of manganese in this State, and possibly, with the exception of the American Manganese Company,

limited; the largest in the United States, was Mr. A. P. Silva, who mined on lot 391 of the land of the Etowah Mining and Manufacturing Company. Mr. Silva began mining in June, and had shipped at the close of the year some 1,500 tons. As has been stated, the methods of mining and recovering the ore used by Mr. Silva enabled him to secure a greater production from a given amount of the manganese drift deposit than had before been obtained.

Analyses made by Prof. H. C. White, State chemist, of the ore from the mines opened on the Etowah property are as follows, lot No. 391 being the opening worked by Mr. Silva:

*Analyses of manganese ore from Etowah, Georgia.*

| | From lot No. 303. | From lot No. 391. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Manganese dioxide | 87.960 | 87.600 |
| Oxides of iron and alumina | 2.520 | 9.135 |
| Sulphur | .008 | .010 |
| Phosphorus | .120 | .065 |
| Silica | 8.350 | 2.175 |
| Water and organic matter | 1.042 | 1.015 |
| Total | 100.000 | 100.000 |
| Metallic manganese | 54.975 | 54.750 |

*Other mines.*—Manganese ore was produced on at least three other properties in the region during the past year.

The Dade Coal Company worked a mine on their property in Bartow county for a short time in the fall of 1885, producing some 100 tons of ore, which was purchased by the agent of an English company and shipped to England. The quality is stated to have been "very good." No analysis has been obtained.

Mr. George W. Satterfield, whose mines are located some 2 miles from Cartersville, mined and shipped to Pittsburgh for blast-furnace use, and to New York, the latter for trans-shipment to England for chemical purposes, some 200 tons of manganese ore. These mines exhibit the general characteristics described above. The ore is stated to occur as "blue, crystallized, and needle" ores.

Mr. James F. Carroll commenced mining in the last quarter of 1885 on the lands of Mr. Larkin Satterfield, adjoining those last mentioned, mining and shipping to Pittsburgh some 180 tons of ore.

An analysis of ore from this property is as follows:

*Analysis of manganese ore (run of mine) from the mines of Larkin Satterfield, Cartersville, Georgia.*

| | Per cent. |
|---|---|
| Metallic manganese | 44.72 |
| Metallic iron | 5.19 |
| Silica | 17.03 |
| Phosphorus | .151 |
| Water | 9.20 |

*Manganiferous iron ores.*—Certain of the iron ores of Georgia as of other States are intimately associated with manganese ores. Similar agencies appear to have been at work in their origin and disposition. It will be found, therefore, that these ores not only take the place of each other in some localities, but that in the manganese regions ores that are classed as manganese carry some amounts of iron, while the iron ores carry at times considerable manganese. Indeed, much of the brown ore throughout Georgia has more or less manganese, some of it so much as to be wholly useless for the manufacture of the grade of pig iron produced in the furnaces of that State. But little of this manganiferous iron ore is used.

## ARKANSAS.

The search for manganese deposits, with the testing of localities that promise profitable returns, is being prosecuted at the present time with more energy in Arkansas than in any other State. Though the output of manganese ore was greater in Virginia and Georgia in 1885 than in Arkansas, and while it is probable that no single mine will, for some time at least, reach the production of the Crimora mine in Virginia, the developments already made in Arkansas indicate a very greatly increased production for 1886. Though there must be still further and extensive investigations to determine with any degree of accuracy the law of the outspread and continuity of the deposits that are known to exist in this State, enough is already known to indicate that the deposits underlie a great extent of contiguous territory, and that the pockets are as a rule quite large. It is also reported that true veins of considerable extent and rich in manganese have been found and traced in the State.

There are two distinct and widely separated localities that promise to furnish manganese in large quantities. One is in the southwestern part of the State, in which true veins of manganese have been found and traced, but from which up to the present time no ore for commercial use has been mined. In the other locality, known as the Batesville, in the northeastern part of the State, mining operations have been carried on for four or five years, and a total of some 5,000 to 6,000 tons produced and shipped. In this locality at the present time several companies with large capital and experience are searching for manganese and preparing to develop on an extensive scale, pits or mines already known to contain the mineral in quantity.

*Production.*—Owing to the irregular and spasmodic way in which mining operations have been conducted in the past, it is not possible to give other than an approximate statement of the production of manganese in this State. Parties who might give the information decline to do so. The estimate of 5,000 tons is probably an overestimate.

*Production of manganese ores in Arkansas, 1880 to 1885 inclusive.*

| Years. | Total amount mined. | Value of ore at mines. |
|---|---|---|
| | *Long tons.* | |
| 1880 | | |
| 1881 | | |
| 1882 | 5,000 | $20,000 |
| 1883 | | |
| 1884 | | |
| 1885 | 1,483 | 5,932 |

*The Batesville district.* —What has come to be known as the "Batesville manganese district" is located in the counties of Independence and Izard in the northern part of Arkansas. Batesville, from which the district takes its name, is a town of some 2,000 inhabitants, situated on the White river, and is the county seat of Independence county. This river, which is navigable after flowing in a direction slightly south of east for some 20 miles from Batesville, makes an abrupt turn and flows almost due south, entering the Mississippi 175 miles below Batesville, 600 miles above New Orleans, 400 miles from Cairo, and 600 miles from Saint Louis. A branch railroad runs from Newport on the main line of the Iron Mountain division of the Missouri Pacific railroad to Batesville. By this road and its branches the distance to Saint Louis is 291 miles; to Cairo, 191 miles. A branch road is projected to connect this Batesville branch with the Kansas City, Fort Scott and Gulf railroad, making the distance by rail to Memphis some 100 miles. The distance from Saint Louis to Pittsburgh by rail is 621 miles; to Chicago, 282 miles.

The manganese deposits are not in Batesville, but so far as ascertained at present, extend from a point just over the line of Izard county a short distance above the mouth of Lafferty's creek, which enters the White river some 20 miles above Batesville, to Casson's mines, three miles north of this town. It has been generally supposed that all of the deposits were north of the White river. It is reported, however, that there are some south of the river.

In the middle section or belt of Independence county the ores are found. The manganese belt is somewhat elliptical in shape, and has a length from east to west of about 16 miles, with an average breadth of about 3 miles. In this distance, however, the ore is by no means continuous, there being frequent interruptions and many places from which the ore is absent. It is probable that 7 or 8 square miles would cover the ascertained extent of the deposits, though explorations in progress may enlarge this. In its topography the ore district is an irregularly located group of rounded hills, 100 to 500 feet above the general drainage level of the country. Two creeks run through the belt, Polk bayou on the east, and as above stated, Lafferty's creek on the west. The ore belt is by no means well watered, however, and did this ore demand thorough

washing there would be considerable difficulty in securing sufficient water for thepurpose. Geologically the country exhibits a monoclinic structure, dipping gently to the southeast from Lafferty's creek towards Batesville. The main portion of the hills above water level are sub-Carboniferous limestone, covered with wash and crowned with broken chert or flint. Underneath the limestone is sandstone.

The ores occur in two horizons, and under two distinct conditions:

I. The drift ores of the northwestern portion of the region.

II. The regular stratified bed of the eastern portion of the belt.

The drift manganese ore is found under the tops of the hills in pieces from the size of a pea up to bowlders 2 and 3 and even 4 tons in weight. The diluvian deposit carrying the ore is from 5 to 25 feet in thickness, averaging say 9 feet, and rests upon a floor of limestone, a brown clay of varying thickness being interposed. This ore drift yields from 12 to 30 per cent. of ore. Above the manganese drift is an earthy wash, interspersed with fragments of chert from 3 to 30 feet thick. At the Southern mine, from which over 5,000 tons have been taken, the stripping is 2 to 25 feet thick, and the drift in which the manganese is found 20 feet thick. The pit at this mine covers a little more than half an acre. At other pits opened the stripping is 10 feet and the ore drift 5 to 11 feet.

The explorations have not as yet been sufficient to indicate the extent of these deposits, nor has enough been learned to justify any general conclusions as to the formation.

The source of the manganese ore lumps is believed to be the "cavernous limestone" found to the northwest of the ore belt, which originally occupied greatly elevated positions. Some of the formation near the mouth of Lafferty's creek, which has escaped the denuding agencies, still carries veins of manganese ore 8 to 14 feet thick.

The ore, which is the black oxide, varies in quality from 40 to 60 units of metallic manganese, is of a bright luster, submetallic in color, subcrystalline, brittle and with a fracture like that of cast iron. The following is the average of thorough analyses of seven shipments. Other analyses of this ore will be found in the volume of Mineral Resources for 1883–84.

*Average compositton of Batesville (Arkansas) manganese ore.*

| | Average of seven analyses. |
|---|---|
| | *Per cent.* |
| Metallic manganese | 50.43 |
| Metallic iron | 3.66 |
| Phosphorus | .164 |
| Water | 2.28 |

A recent analysis shows the following constituents:

*Analysis.*

| | Per cent. |
|---|---|
| Manganese | 58.76 |
| Iron | 3.75 |
| Phosphorus | .14 |

Analyses from three separate pits show the following:

*Analyses of Batesville (Arkansas) manganese ores.*

| | Pit 1. | Pit 2. | Pit 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Metallic manganese | 56.92 | 54.33 | 56.88 |
| Phosphorus | .098 | .228 | .182 |
| Insoluble matter | 2.10 | 1.34 | .72 |

A drift ore gave the following:

*Analysis of Batesville (Arkansas) drift manganese ore.*

| | Per cent. |
|---|---|
| Metallic manganese | 55.95 |
| Phosphorus | .168 |
| Insoluble matter | 1.27 |

The ore has not been washed heretofore. With care in removing the dirt it has been believed that this was not necessary, though dry screening might be advisable. Later advices are to the effect that washing may be undertaken.

The mining cost depends chiefly on the amount of stripping and the percentage of ore in what is termed the "manganese ore drift." From 2 to 5 tons of earth must be removed for every ton of ore, and the drift yields from 12 to 30 per cent. of ore. Two dollars and fifty cents will probably fully cover the mining cost. As the branch railroad at present only extends to Batesville, the ore has to be hauled from the pits to the terminus. This adds to the cost $2 to $2.50. Surveys are in progress for an extension of the railroad through the ore deposits.

The second body of ore is found between the buff-colored sandstone of Batesville and the sub-Carboniferous limestone which forms the floor of the deposits above noted; that is, the first named deposit rests upon the limestone, the second underlies it, or, perhaps better, is in the horizon of transition between the limestone and the sandstone underlying it.

This is a most peculiar deposit. The ore occurs in buttons or concretions embedded in a red matrix of lean siliceous iron ore, the matrix adhering so closely to the "buttons" as to preclude, so far, all attempts to

separate it from the rich manganese in the "buttons." The matrix splits up into rusty slabs 2 to 4 or 5 inches thick. This ore has but little commercial value. An average analysis of this deposit is as follows:

*Average analysis of Batesville (Arkansas) "button" manganese ore.*

| | Per cent. |
|---|---|
| Metallic manganese | 16.46 |
| Metallic iron | 8.70 |
| Phosphorus | .60 |
| Insoluble matter | 43.65 |

*Southwestern Arkansas.*—But little has been learned as to the deposits of manganese ores in this section. They are reported as covering a large extent of territory northwestward from Nashville, and showing both true veins and pockets. The distance of the deposits from railroads have so far interfered with their development. The only analyses obtainable of ores from this region were made with a view to chemical manufacture, and are as follows:

*Analyses of southwestern Arkansas manganese ores.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Protoxide of manganese | 84.995 | 82.448 |
| Oxygen | 10.482 | 10.002 |
| Silica | 2.845 | 5.329 |
| Baryta | .512 | .282 |
| Lime | Trace. | 1.178 |
| Magnesia | ..... | Trace. |
| Water | 1.820 | .611 |

## NEW JERSEY.

In the Triassic rock near Clinton, Hunterdon county, there has been an opening made, at first for iron ore, but it proved to contain ores with a large percentage of oxides of manganese, partly pyrolusite and partly braunite. The sample analyzed contained 47 per cent. metallic manganese, 7 per cent. peroxide of iron, and about 25 per cent. insoluble matter. The ore was tried in blast furnaces, and hopes were entertained of making it valuable in the manufacture of spiegel iron, but these have not been realized.

Though, strictly speaking, there are no manganese ores mined in New Jersey, the zinc ores of Sussex county, which are mined for the zinc, contain considerable manganese. The residuum from working them for the zinc would, of course, contain more manganese per ton than the ore itself, and this is smelted in blast furnaces for spiegel iron.

This zinc residuum is worked by the New Jersey Iron and Zinc Company at Newark and the Passaic Zinc Company in Hudson county. When first made this spiegel iron was known as "franklinite iron," after one of the ores used in its manufacture.

From an interesting article in the *Engineering and Mining Journal*, by Mr. George S. Stone, the engineer of the New Jersey Zinc Company, the following statement concerning these ores is condensed:

The zinc ores which carry manganese, and which are used in the production of zinc at the New Jersey Zinc Company's works, are essentially a mixture of willemite, franklinite, zincite, and calcite, from Sterling and Franklin, Sussex county, New Jersey. The ore from the Sterling Hill mine is principally franklinite and calcite, with a very variable proportion of zincite and but very little silicate. The ore from the front vein of the Taylor mine at Franklin also contains a good deal of calcite with franklinite, willemite, and rhodonite; it is low in zinc. The ore from the back vein, or "Buckwheat Field opening," is the best ore. It contains a large proportion of willemite and zincite, with but little calcite. The following analyses show the composition of the ores:

*Analyses of zinc ores containing manganese, from New Jersey.*

| Constituents. | Selected Buckwheat. | | | Lean Buckwheat. | | Sterling. | | | Front vein. |
|---|---|---|---|---|---|---|---|---|---|
| | No. 1. | No. 2. | No. 3. | No. 1. | No. 2. | No. 1. | No. 2. | No. 3. | |
| $SiO_2$ | 10.21 | 9.91 | 11.08 | 10.28 | 10.33 | 4.86 | 4.43 | 5.15 | 9.78 |
| $Fe_2O_3$ | 31.41 | 31.63 | 27.54 | 30.46 | 30.36 | 30.33 | 30.13 | 27.62 | 27.20 |
| MnO | 15.84 | 16.46 | 17.63 | 15.66 | 15.95 | 12.30 | 12.21 | 13.09 | 17.81 |
| ZnO | 32.83 | 34.07 | 35.88 | 27.15 | 26.34 | 29.42 | 27.12 | 23.38 | 22.94 |
| CaO | 5.09 | 4.08 | 2.01 | 8.45 | 7.15 | 12.65 | 12.63 | 14.37 | 11.46 |
| MgO | ..... | .21 | .77 | .91 | 1.09 | ..... | 1.69 | 1.98 | .74 |
| $Al_2O_3$ | .21 | 80 | .24 | .09 | 1.16 | .67 | .... | .64 | .67 |
| Fe | 21.98 | 22.14 | 19.28 | 21.32 | 21.25 | 21.23 | 21.09 | 19.33 | 19.04 |
| Mn | 12.27 | 12.75 | 13.64 | 12.12 | 12.35 | 9.53 | 9.46 | 11.13 | 13.79 |
| Zn | 26.34 | 27.34 | 28.78 | 21.79 | 21.14 | 23.61 | 21.76 | 18.76 | 18.41 |

The New Jersey Zinc Company is using all but the Front vein ore at present. The Lehigh Zinc and Iron Company, at Bethlehem, Pennsylvania, uses an ore that is between the Buckwheat and the Front vein in composition, and the Passaic Company uses partly Buckwheat and partly ore like the Sterling from a mine of its own.

The ores are mixed in various proportions, limestone being added when necessary, and treated in the oxide furnaces, where the greater part of the zinc is volatilized, to be collected and sold as oxide. The ore is mixed in the oxide furnaces with a large proportion of anthracite culm and dust from coal yards, very high in ash, as the following analysis shows:

*Analysis.*

| | Per cent. |
|---|---|
| Moisture | 4.08 |
| Volatile combustible matter | 6.03 |
| Fixed carbon | 66.64 |
| Ash | 23.25 |

The ash from the culm is, of course, left in the residuum, making it leaner and adding a most objectionable amount of silica and alumina.

The clinker, as it comes from the oxide furnaces, is partly in flat cakes, about 2 inches thick and from 4 to 10 inches in diameter, and partly in small fragments, from dust to 2 inches in diameter. It is screened before going to the blast furnaces, the very fine portion being rejected. The coarse clinker very frequently varies between certain limits, as shown by the following analyses:

*Analyses of clinker from zinc oxide furnaces.*

| Constituents. | 1. | 2. | 3. | 4. | 5. |
|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| $SiO_2$ | 19.97 | 25.02 | 23.47 | 18.14 | 21.29 |
| $Fe_2O_3$ | 33.21 | 31.06 | 33.84 | 36.16 | 31.06 |
| $Al_2O_3$ | 2.25 | 6.36 | 8.24 | 6.94 | 5.98 |
| MnO | 17.83 | 16.22 | 15.66 | 18.90 | 21.03 |
| CaO | 11.96 | 10.73 | 11.04 | 11.81 | 7.60 |
| MgO | 2.30 | 2.67 | 1.84 | 1.98 | 4.01 |
| ZnO | 10.74 | 6.98 | 4.98 | 4.06 | 7.84 |
| P | .037 | | | | |
| Fe | 23.25 | 21.74 | 23.69 | 25.30 | 21.74 |
| Mn | 13.82 | 12.56 | 12.13 | 14.64 | 16.29 |

The last two (4 and 5) are exceptional. The clinker is lean and rather siliceous; it carries, however, nearly enough lime, magnesia, and alumina to flux the silica. The alumina is far from being a desirable ingredient. The zinc oxide varies from 3 to 11 per cent., usually about 6 per cent., and is an unmitigated nuisance. It is all driven off when the furnaces work regularly. Part of it condenses on the throat in a hard, dense ring, which has to be frequently chiseled off at an expenditure of much time and hard labor; part of the remainder collects in the gas flues, condensers, ovens, and boiler settings as a loose powder, and a large part is carried off by the escaping gases and lost.

The new furnace "A" of the New Jersey Zinc Company is the result of a number of most careful experiments as to dimensions, thickness of walls, etc. It makes more iron, carries a heavier burden, and is less troubled by unavoidable stops than any of previous construction. It is 31 feet high to the stock line, 6 feet 6 inches diameter at the throat, 8 feet at the bosh, and 5 feet 3 inches at the tuyeres. The bell is 3 feet 4 inches in diameter. There are five 3-inch and one $2\frac{1}{4}$-inch tuyeres. The walls are 21 inches thick up to the tuyeres, 16 inches on the bosh, 24 inches for the first 10 feet above the mantel, diminishing to 16 inches at the throat. The increased thickness of the walls, by preventing loss of heat by radiation, is one of the principal reasons of the better working of this furnace. From 1 foot below the hearth to 14 inches below the tuyeres, and at the tuyeres and cinder notch, the furnace has cast-iron water jackets. From 14 inches above the tuyeres to the mantel there is a wrought-iron bosh jacket with sprinkling pipes. The coal

unit is 900 pounds. The present charge is 900 coal, 1,275 clinker, 300 limestone—the largest charge that has ever been worked by a furnace using this material. The furnace did not get fairly in working order for the first three months of the blast. For the first six months of the blast the average make was 8 tons 415 pounds of iron with 20.36 per cent. of manganese, requiring 0.029 ton of boiler coal and 2.614 tons of broken coal to the ton of iron; 19.54 per cent. of the iron was 17 to 19 per cent. spiegel, 79.93 per cent. was 20 per cent. spiegel, the remainder, 0.53 per cent., was of lower grades. For the second three months the furnace made 9 tons 1,416 pounds a day with 20.20 per cent. manganese; more than three-fourths of the iron was 20 per cent. spiegel, the remainder 17 to 19 per cent. spiegel. It took 0.019 ton of boiler coal and 2.368 tons of broken coal to the ton of iron. For the past month the make has been over 10 tons 1,500 pounds a day, requiring less than 2.2 tons of coal to the ton of iron.

The residuum used at the furnace of the Passaic Zinc Company averaged as follows:

*Analysis.*

| | Per cent. |
|---|---|
| Silica | 18.56 |
| Oxide of iron | (*a*) 36.21 |
| Oxide of manganese | (*b*) 15.69 |
| Oxide of zinc | 4.70 |
| Alumina | 4.07 |
| Lime | 16.70 |
| Magnesia | 1.92 |
| Carbon (unburnt coal) | 1.85 |

*a* = 25.35 metallic iron. *b* = 12.37 metallic manganese.

The coal and limestone (from High Bridge, New Jersey) were the same as used by the New Jersey Zinc and Iron Company.

The furnace at the Passaic works, built in 1883, is 34 feet 9 inches high, 10 feet diameter at the bosh, and 5 feet 8 inches at the tuyeres. The top was at first closed by a swinging lid, which was not satisfactory, as it allowed much of the gas to escape, and could only be used when the wind was in the right direction. It was finally replaced by a bell and hopper. The furnace has columns 13 feet 6 inches high, and is water-jacketed up to the mantel. The first two blasts were unsuccessful; both were prematurely ended by bad gas explosions, which wrecked the condensers. Before blowing in again the furnace was relined and several alterations and improvements were made in other parts of the plant. The last blast began in the latter part of 1884. It has been very satisfactory.

For the year 1885 the following quantities of materials were used to the ton of iron: Boiler coal, 0.57 ton; furnace coal, 2.29 tons; residuum, 2.89 tons; limestone, 0.63 ton; and scrap, 25 pounds. The average

pressure of the blast was 5½ pounds, the temperature 881° Fahr. The average make per day was 11 tons 1,792 pounds, containing 22.76 per cent. of manganese. All but 41 tons (0.95 per cent.) of the iron made contained over 20 per cent. of manganese.

Though the furnace of the Lehigh Zinc and Iron Company is in Pennsylvania it will be better to give Mr. Stone's statement as to its residuum and workings here. This company built its furnace in 1881. The residuum used is lower than that of the New Jersey Zinc Company, as the following average analysis will show:

*Average analysis.*

| | Per cent. |
|---|---|
| Silica | 25.16 |
| Oxide of iron | (*a*) 28.99 |
| Oxide of manganese | (*b*) 9.45 |
| Oxide of zinc | (*c*) 4.55 |
| Lime | 12.80 |
| Magnesia | 4.55 |
| Alumina | 6.57 |
| Phosphorus | .036 |

*a* = 20.29 metallic iron.
*b* = 7.32 metallic manganese.
*c* = 3.65 metallic zinc.

The silica frequently runs as high as 32 per cent.

The furnace is 32 feet 9 inches high, 5 feet 4 inches diameter at the throat, 8 feet at the bosh, and 4 feet at the tuyeres, with closed top and closed front. It has four tuyeres 3 inches in diameter. The usual pressure of the blast is 4½ pounds, and the temperature 700° Fahr. Average length of blast, sixteen months. The furnace is stopped twice a week, for one hour each time, for cleaning. The gas passes through six condensers, with five pipes to each. These condensers catch 405 pounds of oxide per ton of iron made, an unusually large proportion considering the comparatively small amount of zinc in the residuum used. The following quantities of materials are used per ton of iron made: Boiler coal, 1.08 tons; furnace coal, 2.79 tons; coke, 0.72 ton; residuum, 3.59 tons; limestone, 1.65 tons. The usual charge is, fuel (one-fourth coke), 700 pounds; residuum, 700 pounds; limestone, 320 pounds. The spiegel contains about 14 per cent. of manganese. About 5 tons are made per day. The cinder contains, on the average, 33.33 per cent. of silica and 5.38 per cent. of protoxide of manganese, equal to 3.89 per cent. of metallic manganese—"the lowest amount," says Mr. Stone, "I have ever known in cinder from any furnace using residuum." The Lehigh company has leaner and more siliceous clinker than either of the other companies working the same ores.

The following table shows the comparative working of the different furnaces of these three companies when making spiegel iron:

*Comparative working of the different furnaces.*

| | Number of tuyeres. | Iron made per day. | Furnace. | Furnace per ton iron per day. | Average manganese in spiegel. | Oxide collected per ton of iron made. | Boiler coal per 100 iron made. | Furnace coal per 100 iron made. | Residuum per 100 iron made. | Limestone per 100 iron made. | Charge per day per 100 cubic feet in furnace. | Approximate weight of cinder per 100 iron. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Tons.* | *Cu. ft.* | *Cu. ft.* | *Per cent.* | *Lbs.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Old "A" furnace, top and front open | 3 | $7\frac{922}{2240}$ | 393 | 53 | 17.45 | 367 | 19 | 292 | 305 | 74 | 12.65 | 250 |
| Old "B" furnace, top and front open | 3 | $7\frac{165}{2240}$ | 695 | 98 | 17.55 | 296 | 3 | 292 | 330 | 74 | 7.08 | 270 |
| "C" furnace, top and front open | 5 | $7\frac{338}{2240}$ | 527 | 73 | 19.39 | 448 | 2 | 301 | 317 | 81 | 9.48 | 270 |
| "C" furnace top closed, front open | 3 | $6\frac{549}{2240}$ | 602 | 96 | 17.11 | 132 | 39 | 332 | 356 | 90 | 8.07 | 300 |
| New "B" furnace, top and front closed | 6 | $8\frac{927}{2240}$ | 1,139 | 135 | 20.74 | 231 | 3 | 264 | 303 | 76 | 4.76 | 250 |
| New "A" furnace, top and front closed | 6 | $9\frac{1418}{2240}$ | 1,232 | 128 | 20.20 | 176 | 2 | (*a*)237 | 317 | 77 | 5.00 | 250 |
| Lehigh furnace, top and front closed | 4 | 5 | 925 | 185 | 14.00 | 405 | 108 | (*a*)351 | 359 | 165 | 4.74 | 300 |
| Passaic furnace, top and front closed | 5 | $11\frac{1722}{2240}$ | 1,466 | 124 | 22.76 | 259 | 57 | 229 | 289 | 63 | 4.67 | 190 |

*a* One-fourth coke.

The figures for the first five furnaces are averages for the entire blast; for furnace "A," for the second three months of the blast (it is doing much better at present). It is not stated how long a period the figures for the Lehigh furnace cover. For the Passaic they are the average for the year 1885, which leaves out the first and last parts of the blast, and consequently makes a more favorable showing than if the entire blast were included.

In making comparisons, it must be remembered that the former New Jersey furnaces cut out so rapidly at first that, by the end of a month, their volume was nearly doubled. The New Jersey Zinc Company's furnaces, with the exception of C, closed top, had residuum of nearly equal quality. The Lehigh furnace has considerably leaner and the Passaic rather richer and much less siliceous residuum.

## NEW ENGLAND STATES.

Manganese has been found in a number of localities in the New England States, chiefly as wad, however, and of little commercial value. In Maine considerable bog manganese was mined at one time in Knox, Oxford, and Hancock counties. In Blue Hill, Hancock county, what is termed a silicate of manganese has been mined at several dates since 1863. The manganese occurs in a vein about 15 feet in width on the summit of Blue Hill. The hill is a mass of contorted gneiss rock, the manganese running through it east, northeast by west, southwest. In

1877 and 1878 some 120 tons were taken out of this mine for use as flux at the furnace of the Katahdin iron works, since which time the deposit has not been worked. The following are analyses of the ore:

*Analyses of manganese ore from Blue Hill, Maine.*

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Protoxide of iron | 14.01 | 24.91 | 12 |
| Protoxide of manganese | 35.13 | 29.72 | 15 |
| Alumina | 7.45 | 3.04 | ..... |
| Lime | 3.49 | 5.02 | ..... |
| Silica | 35.84 | 35.70 | 39 |
| Phosphoric acid | 1.02 | ..... | ..... |

No. 1 was made by Prof. R. H. Rickard, No. 2 by the Scranton Steel Company, No. 3 by the Cambria Iron Company.

In New Hampshire some pyrolusite is found in connection with silicate of manganese in Cheshire county.

In Vermont quite a number of deposits of various ores of manganese, such as braunite, psilomelane, and pyrolusite, are noted. Rutland county gives several localities.

In the western part of Massachusetts, in connection with the limonite ores of that section, pyrolusite is frequently found, though rarely, if ever, in sufficient quantities to justify mining it for manganese. These limonites carry at times as much as 4 per cent. protoxide. In Conway, Franklin county, "large beds," with quartz gangue, are reported.

In Connecticut manganese in connection with the iron ores of Salisbury district is of quite frequent occurrence, though no manganese is produced separately. Attempts have been made to find the manganese ore in sufficient quantities to pay for separating it from the iron ore, but without success.

In Rhode Island only bog manganese is reported.

## PENNSYLVANIA.

Manganese ore is of quite frequent occurrence in Pennsylvania, although but few deposits have yet been discovered that have been worked. Perhaps the largest mines worked in the State were two at Ironton, in Lehigh county, in connection with iron ore. In the iron mines of the Ironton Company, the Balliet Brothers, and the Balliet Heirs, which form one excavation, manganese ore has been twice met with in local beds in considerable quantities. One deposit overlaid a portion of the brown hematite, and the other was just above the limestone under the brown hematite and separated from it by a red clay. Several hundred tons were taken from these beds. The following analyses are by Mr. A. S. McCreath (1) and Mr. Henry Pemberton, jr. (2):

*Analyses of manganese ores from Lehigh county, Pennsylvania.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 52.631 | 56.58 |
| Metallic iron | 2.562 | ..... |
| Phosphorus | .063 | Trace. |
| Sulphur | Trace. | ..... |

Another sample from the Ironton Company's mine gave:

*Analysis of manganese ore from the Ironton Company's mine.*

| | Per cent. |
|---|---|
| Metallic manganese | 17.648 |
| Metallic iron | 26.400 |
| Phosphorus | .095 |
| Sulphur | .010 |
| Insoluble residue | 21.860 |

In this district the brown hematites often contain some manganese, 0.5 per cent. to 3 per cent. not being uncommon.

In addition to its occurrence in these Lehigh mines, it has been noticed in many of the mines of Northampton and Berks; in Blair, Centre, and Huntingdon, and at various localities on Broad mountain. In the No. XI. red shale of the Ground Hog valley in Broad Top, there is a lead of manganese ore, 2 to 3 feet thick, carrying 50 per cent. metallic manganese and 0.4 per cent. phosphorus.

At an iron ore bank in York county, near Myer's Mills, leased by the Ashland Iron Company, of Maryland, is a manganiferous iron ore (limonite) that gives the following analysis (McCreath):

| | Per cent. |
|---|---|
| Metallic manganese | 15.934 |
| Metallic iron | 32.400 |
| Phosphorus | .651 |
| Sulphur | .027 |

As stated above, few of these deposits are of sufficient extent to justify mining for manganese. Others are too high in phosphorus for steel purposes, or too low in manganese to justify shipping abroad for chemical manufacture.

In this State there are three blast furnaces making ferro-manganese and spiegel iron regularly, that of the Lehigh Zinc and Iron Company, at Bethlehem, using zinc residuum, and the Conemaugh furnace of the Cambria Iron Company, and furnace "A" of the Edgar Thomson Steel Works at Pittsburgh, both using manganese and manganiferous iron ores.

## MARYLAND.

As noted in the report for last year, manganese was at one time mined in Maryland. A deposit of black oxide was worked at Brookeville, Montgomery county, and another on the Maryland side of the Potomac, across from Harper's Ferry. None is at present mined in the State.

## NORTH CAROLINA.

Though manganese ores have been found in quite a number of localities in this State, no ore was mined, so far as has been learned, in 1885. Some of these deposits appear to hold the same relation to the iron ores and to the several mountain ranges as certain of the manganese ores of Virginia.

In the Buckhorn iron mine, located in Chatham county, on the borders of Harnett county, sheets of laminated black oxide 1 to 2 inches thick occur, and the lower part of the bed of iron ore is quite manganiferous. An analysis of this lower part gives:

*Analysis of manganese ore from Chatham county, North Carolina.*

| | Per cent. |
|---|---|
| Oxide of manganese | 22.80 |
| Metallic iron | 18.41 |
| Phosphorus | .02 |
| Silica | 30.50 |
| Alumina | 19.20 |

At an iron ore bank on Whetstone mountain a manganiferous limonite, with 5 to 6 per cent. manganese, is found.

In Madison and Cherokee counties there "are favorable prospects for large quantities of the ore." Indeed, many of the brown iron ores in this State are accompanied by manganese ores, and at times these are true manganiferous iron ores. The furnaces using these brown ores not infrequently produce a low spiegel by reason of the high percentage of manganese present.

The quantity of manganese ores, or those with over 44 per cent. to 45 per cent. of manganese, does not appear to be large; when ore as rich as this is found it is in very small seams or pockets.

## TENNESSEE.

So far as has been learned the only manganese mined in this State in 1885 amounted to a few hundred pounds in Hickman county for use in coloring earthenware. There are, however, quite a number of localities in which both manganese ore and manganiferous iron ores have been found, but up to this time the manganese deposits examined are small in extent, and of but little commercial importance. A brown hematite or

limonite iron ore with a large percentage of manganese was at one time mined in Greene county, and used as a mixture with other iron ores in a blast furnace, but no recent attempts to use these ores in the manufacture of iron have been discovered.

The Hickman deposit above referred to is near Whitfield. It has been worked to a small extent since 1837. The ore outcrops in a number of places along the banks of a little stream. It is probably found in connection with iron ore, though information on this point is not definite. This country is quite rich in iron ores, but lack of railroad facilities has interfered with their development.

## ALABAMA.

In the neighborhood of Woodstock, Bibb county, Alabama, a manganiferous brown hematite ore is mined for furnace use. It occurs in a thin vein or crust, varying in thickness from 1 to 3 feet, resting upon the main body of hematite ore, which is some 25 feet thick. The manganese portion analyzes as follows:

*Analysis of a manganiferous brown hematite iron ore from Bibb county, Alabama.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic iron | 38.50 | 41.76 |
| Metallic manganese | 11.44 | 13.68 |
| Silica | 11.45 | 24.65 |
| Phosphorus | .27 | .55 |
| Combined water | 11.62 | 10.66 |

In mining the iron ore no attempt is made to separate the manganiferous portion, but both grades are charged into the furnace together. The proportion of manganese in the charge is small, but sufficient to give the cinder the greenish tinge indicative of its presence.

This deposit is some 2 miles east of the limits of the great Black Warrior coal basin. Its northern terminus is some 20 miles southwest of Birmingham, on the line of the Alabama Great Southern railway.

In a paper read before the American Institute of Mining Engineers on the geology of Alabama, by E. J. Schmitz, of New York, the following analyses of manganese ores from this State are given:

*Analyses of manganese ores from Alabama.*

| No. | Variety. | Formation. | County. | Analyst. | Peroxide of manganese. | Specific gravity. |
|---|---|---|---|---|---|---|
| 1 | Pyrolusite | Metamorphic | Chilton | Endemann | 71.220 | |
| 2 | Psilomelane | Silurian | Talladega | Mallet | 62.430 | 3.712 |
| 3 | Psilomelane | Metamorphic | Randolph | Mallet | 63.250 | 3.988 |

## MICHIGAN.

Several years since a deposit of manganese near Copper Harbor was worked to some extent, and several hundred tons of mineral shipped to Pittsburgh. Only some 100 tons, however, proved to be manganese ore. This was used in the furnaces of the Cambria Iron Company at Johnstown. Analyses of this ore available for its manganese are as follows:

*Analyses of manganese ores from near Copper Harbor, Michigan.*

| | No. 1. | No. 2. | No. 3. | No. 4. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Metallic manganese | 49.14 | 46.33 | 46.26 | 37.17 |
| Metallic iron | 1.22 | 5.68 | 1.00 | 2.30 |
| Phosphorus | .019 | .022 | .011 | .028 |
| Silica | 12.90 | 12.79 | ..... | 17.56 |
| Copper | 2.21 | 1.60 | .98 | 1.05 |

At the McComber mine, at Negaunee, pockets of manganiferous iron ores are occasionally met with, some of which are 25 feet across and of a good quality. An analysis of an average sample of this ore is as follows (Charles E. Wright):

*Analysis of McComber, Michigan, manganese ores.*

| | Per cent. |
|---|---|
| Oxide of iron | 71.430 |
| Oxide of manganese | 17.250 |
| Alumina | 2.200 |
| Phosphoric acid | .073 |
| Sulphuric acid | .073 |
| Silica | 2.050 |
| Water combined | 5.320 |
| Undetermined | 1.604 |
| | 100.000 |
| Metallic iron | 49.80 |
| Metallic manganese | 10.90 |
| Phosphorus | .034 |
| Sulphur | .021 |

In 1877 advantage was taken of the fact that the Munising furnace was about blowing out for repairs to make a test of this ore for the manufacture of spiegel, some 50 tons being charged. An analysis of the pig gave 10.6 per cent. of manganese and 0.120 per cent. of phosphorus.

## MISSOURI.

Considerable quantities both of manganese ores and manganiferous iron ores have been mined in Missouri for use in the Saint Louis furnaces in the manufacture of spiegel iron. These ores have been derived chiefly, if not entirely, from what Professor Pumpelly has termed the "porphyritic" region of Pilot Knob and vicinity, and are usually found associated more or less intimately with iron ore. In 1881 some 2,000 tons of this ore

were taken from one mine in this section, but since that year none has been mined on a commercial scale.

On what has been termed the "Cuthbertson Buford Hill" in this Pilot Knob region several deposits occur, from which the ore already referred to was chiefly derived. On the Cuthbertson tract masses of float manganese ore, varying greatly in size, are found, and in the hill occurs a bedded deposit of irregular tabular masses of manganese ore bedded in red ocherous clay. The manganese exists in the ore as red sesquioxide, with a probable admixture of binoxide. This ore is a true manganese ore, as will be seen from the following analysis:

*Analysis of Cuthbertson (Missouri) manganese ore.*

[Chauvenet and Blair, chemists.]

| | Per cent. |
|---|---|
| Manganese as protoxide | 68.20 |
| Peroxide of iron | 3.30 |
| Insoluble siliceous matter | .44 |
| Metallic manganese | 52.47 |

The ore of the Buford bank adjoining the Cuthbertson tract is a manganiferous iron ore, but it occurs in a bedded deposit similar to Cuthbertson's manganese ore. An analysis of this by Mr. Chauvenet gave the following results:

*Analysis of manganese ore from Buford bank.*

| | Per cent. |
|---|---|
| Manganese as protoxide | 15.84 |
| Peroxide of iron | 68.30 |
| Insoluble matter | 8.54 |
| Sulphur | .017 |
| Phosphoric acid | .102 |
| Or— | |
| Metallic manganese | 12.32 |
| Metallic iron | 47.81 |
| Phosphorus | .044 |

A small amount of manganiferous iron ore was taken from Buford mountain some years since for use at the Vulcan Steel works at Saint Louis. The ore averaged about 15 per cent. manganese. The deposit was some distance from the railroad and it was not deemed advisable to prosecute mining.

Near Cuthbertson, on Mr. Marble's land, Professor Pumpelly found a manganese deposit forming an inner stratified layer 3 to 5 inches thick, in a decomposed porphyry, showing 51.06 per cent. of manganese as protoxide.

Mr. P. N. Moore, an assistant of the Geological Survey of Missouri, reports the existence in Reynolds county, as one of the members of a series of bedded porphyry rocks, an ore of the black oxide of manganese, occurring in narrow comby strings in the porphyry. A very compact

hard specimen of this, so hard that it struck fire with steel, gave Mr. Chauvenet the following analysis:

*Analysis of manganese ore from Reynolds county, Missouri.*

| | Per cent. |
|---|---|
| Manganese as protoxide | 37.04 |
| Manganese as peroxide | 5.48 |
| Insoluble silica | 45.55 |

The 2,000 tons referred to above as being mined in this State in 1881 were from the property of the Arcadia Mining Company, near Arcadia, Missouri. The analysis was as follows:

*Analysis of Arcadia, Missouri, manganese.*

[Farrell, chemist.]

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 64.98 | 58.02 |
| Metallic iron | 2.82 | 3.35 |
| Phosphorus | .04 | .03 |
| Silica | 2.82 | 3.35 |

This ore was used in the furnaces of the Missouri Furnace Company at Saint Louis in such quantities as to give three-fourths per cent. of manganese in the iron. The analyses above given were of exceptionally rich specimens of the ore.

## ROCKY MOUNTAIN REGION.

The occurrence of manganese throughout the mining regions of Colorado is quite common, but as a rule the ores found are in small quantity and unavailable for use. In the Leadville district an ore known locally as the "Leadville iron flux" is used to a considerable extent. This ore is practically a manganiferous iron ore containing silver. It contains usually a trace of lead and from 7 to 12 ounces of silver per ton, and the following amounts of silica, iron, and manganese:

*Analysis.*

| | Per cent. |
|---|---|
| Silica | 8 to 15 |
| Iron | 35 to 50 |
| Manganese | 8 to 15 |

Sometimes the manganese in these ores runs as high as 20 per cent., and even higher, though in large quantities, say from 50 to 200 ton lots of the "iron flux," the averages are as above given. Towards the close of 1885 the Omaha and Grant Smelting and Refining Company was using from 60 to 80 tons per twenty-four hours of this ore. As is the

case with the argentiferous manganese ores of Montana, these are not utilized for their manganese, but for their silver and for the fluxing qualities imparted to them by the iron and manganese. Dr. Malvern W. Iles, to whom I am indebted for this information, states that aside from this manganiferous iron flux, found so abundantly at Leadville, he has noticed manganese in many places in Colorado, but does not know of any large deposits of any of the well known manganese minerals which are mined solely for their manganese.

In Montana the ore from several veins in the Butte mining district is composed almost entirely of manganese compounds. In "Mineral Resources of the United States, 1883 and 1884," on page 379, the manner of occurrence of the manganese here is stated. The ores containing the oxides of manganese are in great demand at Butte by the smelters for use as flux. Analyses are given in the same volume, on pages 379 and 380, of several samples from Butte. No manganese ores are mined for the manganese, but are utilized solely for their silver and fluxing qualities. Some 4,263 tons of these ores, worth $10 a ton on an average, were treated at Butte in 1885. They were estimated to carry 67.75 per cent. $MnO_2$, but the method of assay was crude. The ore is assayed for insoluble residue and the remainder credited to $MnO_2$.

Little or nothing is known of the occurrence of manganese ores in New Mexico, Wyoming, Idaho, or Dakota.

## PACIFIC STATES.

There are a number of known deposits of manganese ores in the Pacific States, especially in California and Nevada. The relation of most of them to transportation is such that at present few have any commercial value. There is no doubt, however, that at some time these States will be large producers and exporters of this mineral.

In Nevada some 200 tons of manganese ore were taken in 1885 from a mine some 3 miles from Golconda station, Humboldt county, on the Central Pacific railroad. None of this was shipped, owing to the difficulty in finding a market. Mr. J. R. Jennings, the proprietor of the mine, writes that he "can put in San Francisco a 75 per cent. manganese ore at $11 per ton." This would preclude shipments. The ore is both black and yellow. Analyses of the black oxide show 60 to 85 per cent. oxides of manganese. The deposit is described as a regularly defined ledge, of which the outcrop can be traced for some 300 feet. The ledge is from 3 to 10 feet thick.

In California there are several known deposits of manganese, some of which are not far from tidewater at San Francisco. In the two previous volumes of "Mineral Resources of the United States," a number of these localities are mentioned. So far as has been learned the only deposit producing any ore in 1885 was at Livermore, Alameda county. Some 200 tons a year are mined in this locality, and shipped to San Francisco and other places in California, chiefly for use in working

sulphuret gold ore. The ore is in pockets, which are said to be quite large. It is quite rich, yielding more than 55 per cent. of manganese. These mines are located on a railroad only 50 miles from San Francisco.

## CANADIAN MANGANESE.

*New Brunswick.*—Manganese ores, some of them of the highest grade, are found in a number of localities in this Province. A recent list of localities of minerals in New Brunswick, published by Mr. F. W. Stockton, in the *Canadian Gazette*, mentions its occurrence in King's, Albert, Westmoreland, Gloucester, and St. John counties.

More than fifty years ago manganese was shipped from Quacco, in St. John county, to the United States and England. The ore was taken out of the Bay of Fundy, below high-water mark, but a storm with heavy sea and high tide filled the pit with gravel, and it was abandoned. Thirty years later manganese was again mined along the shore by several parties in a desultory way, and again within the last five years operations have been carried on, but always resulting in loss to the persons most interested. The ore found here is not of high quality.

About thirty-five years ago manganese of excellent quality was mined at Hopewell, in Albert county, but owing to various causes the mines were closed after being in operation a few years. Since that time the mines have been opened several times by different individuals or companies, but have not been profitable to any one.

The most important manganese mine in Canada is situated at Markhamville, in King's county. The works have been in active operation for upwards of twenty-three years, and about 30,000 tons of manganese have been shipped to Europe and the United States. Notwithstanding the great depression during the last three or four years in business of all kinds, particularly in mining, these mines have been successfully worked. The company has a very complete plant, using steam mills and high explosives, pumps and hoisting engines in the mines, also improved and novel appliances for washing and dressing the ores. A rotatory saw-mill and other machines for preparing timber for underground work, and for building purposes, crusher and mills for preparing the various ores for use of consumers have been supplied.

One of the most important features of these mines is their production of almost all kinds of manganese ores, viz., pyrolusite of the very best quality and highly crystallized manganite and braunite; the two latter, being free from phosphorus and high in metallic manganese, are particularly adapted for steel manufacturers. These ores have a well known standing in the English market. The output since 1880 has been nearly 2,000 tons annually, four-fifths of which has gone to Europe, principally to England, and one-fifth to the United States, the latter almost all high-class ores for glass making. The mines are owned and worked by Bos-

ton capitalists, under the management of Mr. Alfred Markham, to whom I am indebted for many of the facts concerning New Brunswick manganese.

An analysis of one grade of their furnace ore (No. 3) is as follows:

*Analysis of manganese ore from New Brunswick.*

| | Per cent. |
|---|---|
| Peroxide of iron | 3.75 |
| Peroxide of manganese | 52.74 |
| Carbonate of lime | 13.40 |
| Silica | 9.50 |
| Sulphur | .02 |

This is used as a flux at the Katahdin furnace in Maine.

The other mine in this province producing manganese in 1885 was that of Mr. F. W. Stockton, some 6½ miles from Sussex station. This is a new mine, producing a high-grade ore. Some 100 tons were mined in 1885.

*Nova Scotia.*—Through the kindness of Mr. Edwin Gilpin, jr., chief inspector of mines of the Province of Nova Scotia, I am enabled to give the following facts regarding manganese in this Province:

The least valuable but certainly the most common of the Nova Scotia manganese ores is wad. This ore is found as a superficial deposit in connection with every geological formation known in the Province. Among the localities yielding it may be mentioned Jeddore, Ship Harbour, Saint Margaret's Bay, Shelburne, La Have, Chester, Parrsborough, Springhill, Pictou, and Antigonish. These ores exhibit the varying composition which characterizes their class, and have in some cases been used to a limited extent as paints.

At the Londonderry Iron mines, Colchester county, in the great vein of brown hematite, associated with ocher, ankerite, sideroplesite, and calcite, in strata of Lower Silurian age, secondary changes have at some points enriched the iron ore with manganese peroxide up to 14 per cent. of its total constituents. Some incrusting fibers are manganite, and part of the manganese is present in the form of wad, of which Mr. H. Louis gives the following analysis:

*Analysis of manganese ores from Nova Scotia.*

| | Per cent. |
|---|---|
| Manganese peroxide | 67.10 |
| Manganese protoxide | 10.67 |
| Water | 9.37 |
| Copper protoxide | .88 |
| Iron protoxide | 4.09 |
| Alumina | .67 |
| Nickel and cobalt oxide | .65 |
| Lime | 2.49 |
| Magnesia | Trace. |
| Silica | 4.08 |
| Total | 100.00 |

The occurrence of this ore in the pre-Carboniferous rocks is interesting, as showing its originally wide distribution, and as possibly indicating the sources of part of the more recent ores of economic value.

Pyrolusite is the only ore of manganese which has hitherto been mined to any extent in Nova Scotia, and it is known to occur in pre-Carboniferous strata at several points. Between Halifax and Windsor, near Mount Uniacke, pyrolusite is found in small pockets and veins penetrating granite, and in quartzites of the auriferous Lower Cambrian of the Nova Scotia Atlantic coast. It occurs in veinlets in the granite of Musquodoboit, and as small irregular seams in the granite of Ship Harbour. In the hills south of Wolfville, in King's county, the same ore is found in quartzites and slates, presumably of Upper Silurian age. In the Trias of the same county the ore is met in a bedded form near Cornwallis and Wolfville, and in the Triassic trap it is said to occur lining cavities, in association with zeolites, etc.

These ores are found, however, most abundantly in the Lower Carboniferous marine limestone formation. This horizon forms one of the widest spread and most strongly marked of the divisions of the Carboniferous age. It is met in King's county, in Hants, Cumberland, Colchester, Pictou, and Antigonish, and in the four counties of the island of Cape Breton.

In the northern part of Hants county, the Carboniferous marine limestones and the underlying lower coal measures are found in a series of east and west folds, shifted and broken by transverse subordinate flexures. The presence of manganese in the upper of these divisions is first observable at the mouth of the Shubenacadie river, where a dark-colored limestone underlies the gypsum, and is associated, a short distance east of the river, with red shales, carrying veins of red hematite, with manganese oxides and calcspar. The westward continuation of this horizon is noticeable again at Tenny Cape, where a series of these measures, extending to Walton and Cheverie, a distance of about 15 miles, contains several beds of limestone, which apparently underlie the gypsum, and may be called manganiferous. These measures carrying manganese reappear again south of Windsor, and at Douglass, 15 miles south of Tenny Cape, near the line of their junction with the pre-Carboniferous rocks. In this range of measures the manganese of Tenny Cape appears to be principally connected with a compact red and gray limestone, which, from the analysis already given, may be called a dolomite. At the western end of the district it occurs as veins in conglomerates and sandstones, and also in limestones in places decidedly magnesian.

The Tenny Cape manganese ores were discovered about the year 1862, and have been worked intermittently since that date. The limestone band to which they seem to be principally confined is about 300 feet thick. The ore occurs in irregular nests, and in seams eroded on the bedding planes and cross fractures. It thus occurs that large

masses almost entirely isolated have been met; also seams with occasional pockets, sometimes connected, but in no case, so far as ascertained, following any regular order of position or extent. The largest mass yet found was estimated to contain 180 tons of ore. Apparently the ore has been deposited at irregular intervals of time, with the associated minerals, in the openings worn by the action of water on the limestones. Specimens may be obtained showing pyrolusite cementing waterworn pieces of limestone and surrounding nodules of the bed rock which have resisted erosion. The ore is chiefly a fibrous pyrolusite, with splendent luster, based on a compact or granular ore consisting of pyrolusite, psilomelane, and manganite, the latter mineral, however, not being present in large quantity. The quality of these ores, even after the slight hand dressing they receive at the mines, is very high, and in some years they bring $125 a ton at the mine. They are prized by glass makers for their freedom from impurities, especially of iron. This high grade of the pyrolusite from the Tenny Cape district will appear when, from numerous assays, it has been found to yield from 88 to 95 per cent. of available oxide. The following analyses show the general character of these ores:

*Analysis of manganese ores from Tenny Cape district.*

| | Douglas. | Cheverie. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Moisture | 1.650 | 2.05 |
| Water of composition | 3.630 | ..... |
| Iron peroxide | .603 | ?.55 |
| Oxygen | 7.035 | ..... |
| Baryta | .724 | 1.12 |
| Insoluble matter | 1.728 | 2.80 |
| Phosphoric acid | ..... | 1.029 |
| Manganese oxides | 84.620 | ..... |
| Peroxide of manganese | ..... | 90.15 |
| Lime | ..... | Trace. |
| Totals | 100.000 | 99.699 |

At Walton and Cheverie manganite is more common than at Tenny Cape. Its mode of occurrence is similar, and its general character is shown by the following analyses:

*Analyses.*

| | Tenny Cape. | Cheverie. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Manganese oxides | 85.54 | 86.81 |
| Iron peroxide | 1.18 | 2.05 |
| Baryta | .89 | |
| Insoluble matter | 3.27 | 1.14 |
| Phosphoric acid | .34 | ..... |
| Water | 8.54 | 10.00 |
| Available oxygen | 51.54 | 47.73 |

The Tenny Cape manganite is compact, with partly fibrous structure, and submetallic luster. It is not much in demand at present, but it is stated that considerable quantities could be obtained at several points.

Lower Carboniferous limestones at Minudie, in Cumberland county, have yielded small quantities of a soft fine-grained pyrolusite, giving on analysis 97.04 per cent. of manganese binoxide. Ores similar to those of Tenny Cape are found at Onslow, and on the Salmon river, near Truro, Colchester county. Prospecting work has shown red shales and sandstones, and beds of dark-bluish limestone, covered by beds of gravel and clay holding nodules of compact subcrystalline pyrolusite. The ore also occurs in veins, up to 4 inches in thickness, in the sandstones, and in irregular nests and layers in the limestone. Calcspar, barite, and selenite are found in the veins, which are filled with fibrous ore. The exact horizon of the beds holding these ores is not readily ascertainable, and it may be higher in the marine limestone formation than at Tenny Cape. The ore is of very good quality, some of it running as high as 90 per cent. of available oxide. In Pictou county, near Glengarry station, nodules of fibrous pyrolusite, containing 84 per cent. of peroxide, are found with crystals of dogtooth spar, in a dark-blue limestone, similar to that at Springville, already referred to, and exposed close to the junction of the marine limestone with pre-Carboniferous rocks.

Bowlders of a mixture of psilomelane with manganite occur lying on the limestone at Springville, and on the associated red shales. At several points in this vicinity the limonite ores, found along the line of junction of the Upper and Lower Silurian with the Lower Carboniferous marine limestone, are heavily charged with manganese. The ore is dull brownish-black in color, with a black streak, and softer than the normal limonite. The percentage of manganese present in the iron ore varies. The general character of this ore, however, will appear from the following analysis by Mr. Edward Gilpin:

*Analysis of manganese ores from Springfield, Nova Scotia.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Water of composition | } | 12.530 |
| Moisture | 1.450 } | |
| Insoluble residue | 2.731 | 25.130 |
| Alumina | 2.880 | Trace. |
| Iron sesquioxide | 10.848 | 48.223 |
| Manganese sesquioxide | 62.950 | ..... |
| Manganese peroxide | ..... | 14.410 |
| Magnesia | 1.630 | ..... |
| Lime | 7.280 | .015 |
| Baryta | .670 | ..... |
| Carbonic acid | ..... | ..... |
| Sulphur | ..... | .480 |
| Phosphorus | ..... | .020 |
| Totals | 90.439 | 100.808 |

In Antigonish county similar ferriferous manganese ores have been found in drift at several places.

*Cape Breton.*—In Cape Breton, deposits of manganese of economic value occur only in the western part of the county of the same name. The manganese ores at the Mosely Iron mines, Loch Lomond, the most important deposit in the island, were discovered three years ago, in a recess where the felsites were succeeded by shales and grits, and finally by limestones, the latter apparently extending from point to point of the ancient bay. The ores at the western mine are found in irregular bedded layers in a soft arenaceous reddish-colored shale, which is in some places calcareous and coated with films of manganese oxide. The layers vary in thickness up to 18 inches, and are frequently connected by cross stringers of ore. The shales when weathered present the ore in small nodules, and the disintegration of the former by water probably indicates the source of the beds of gravel manganese ore found lying on them. The ore at the eastern mine occurs as a bed immediately underlying a layer of black manganiferous limestone, with red and greenish shales and coarse grit. The thickness of the ore and limestone varies from 2 to 8 inches, the average thickness of the two being about 8 inches. The ore also occurs in this vicinity as lenticular and irregular nests in conglomerate, &c., and sometimes forms the cementing material. This latter mode of occurrence is similar to that shown by the red hematites (sometimes highly manganiferous) found at various points in the Lower Carboniferous conglomerates of the island near their junction with the older strata. The analysis of the overlying limestone has already been given. The ore from this locality is generally a pyrolusite, soft, fine grained, and sometimes subcrystalline. It is at some openings mixed with manganite, and the latter ore is abundant at several places in the grits. The minerals associated with the ore are calcspar, barite, films of selenite, and limestone. Analyses by Mr. Hoffman, of the Canadian Geological Survey, show that the ores run as high as 88.9 per cent. of binoxide, and contain an admixture of ferric oxide as low as two-tenths of 1 per cent.

On the Magdalen Islands manganese ores are found, according to Mr. Richardson (Geological Survey Report 1879–'80), associated with sand, clay, gypsum, and doleritic rocks of Lower Carboniferous age. From Mr. Hoffman's report (see above) the ore is a purely crystalline manganite, yielding, on analysis, 45.61 per cent. of binoxide. Samples have, however, been seen of pure pyrolusite from these islands. There do not seem to be any limestones connected with these ores, as surveyed by Mr. Richardson, and the locality appears to form an exception to the rule which, so far as my information goes, governs the presence of manganese ores in the Carboniferous of Nova Scotia, viz., the presence of limestone. Possibly in the case of these Magdalen Island ores they may have been derived directly from the dolerite.

*Production.*—The production of manganese ore in Nova Scotia since 1872 has been as follows:

*Production of manganese ore in Nova Scotia from* 1872 *to* 1885, *inclusive.*

| Years. | Mines. | Production. | Value. |
|---|---|---|---|
| | | *Long tons.* | |
| 1861 to 1871 | | 1,500 | $10,500 |
| 1872 | | 40 | 1,400 |
| 1873 | | 131 | ..... |
| 1874 | | ..... | ..... |
| 1875 | | 7 | ..... |
| 1876 | | 16 | ..... |
| 1877 | | 97 | 5,335 |
| 1878 | Tenny Cape No. 1 | 79 | 4,345 |
| | Tenny Cape No. 2 | 48 | 2,160 |
| | | 127 | 6,505 |
| 1879 | Tenny Cape No. 1 | 90 | 4,950 |
| | Tenny Cape No. 2 | 55 | 2,220 |
| | | 145 | 7,170 |
| 1880 | Windsor | 62 | 2,831 |
| | Walton | 81 | 3,600 |
| | Cheverie | 70 | 7,000 |
| | Others | 70 | 1,400 |
| | | 283 | 14,831 |
| 1881 | Tenny Cape | 125 | ..... |
| | Walton | 7 | ..... |
| | Cheverie | 17 | ..... |
| | Pembroke | 6 | ..... |
| | Windsor | 6 | ..... |
| | Loch Lomond, Cape Breton | 70 | ..... |
| | | 231 | ..... |
| 1882 | Tenny Cape | 120 | ..... |
| | Walton | 6 | ..... |
| | Cheverie | 21 | ..... |
| | Onslow | 6 | ..... |
| | Loch Lomond, Cape Breton | 56 | ..... |
| | | 209 | ..... |
| 1883 | Tenny Cape | 125 | 12,462 |
| | Walton | 5 | |
| | Cheverie | 4 | |
| | Loch Lomond, Cape Breton | 16 | ..... |
| | | 150 | 12,462 |
| 1884 | Tenny Cape | 126 | 11,970 |
| | Windsor | 5 | 550 |
| | Cheverie | 2 | 180 |
| | Walton | 89 | 8,430 |
| | Onslow | 30 | 2,700 |
| | Loch Lomond, Cape Breton | 50 | ..... |
| | | 302 | 23,830 |
| 1885 | | 354 | ..... |

# CHROMIUM.

By David T. Day.

*Present condition of the industry.*—The development of chromium interests during the past year has been limited to adding a few new mines to many already worked in California. The depression from foreign competition is felt keenly, so that the extension of mines has been markedly checked, and those now in existence have not been worked to the full extent.

The most noteworthy mine among those opened since the last report is that at Livermore, Alameda county, California. Here, on the top of Cedar mountain, Mr. A. Mendenhall discovered chrome iron ore about three years ago. Much prospecting has been done, and five tunnels opened; of these, two have proved rich in chrome iron ore. Although the ore occurs in isolated pockets, which may be exhausted at any date, these mines continue profitable, and have increased in richness, contrary to the general rule. The two main tunnels are worked by Mr. E. N. Knight, of San Francisco, in the interest of Philadelphia manufacturers. Nearly 400 tons of ore were mined at Livermore in 1885. It is brought down Cedar mountain in wagons, and, in spite of this expensive method of transportation, is delivered in Livermore at a cost of $6 per ton, of which $2 is paid to owners of the mine, $1 for mining, and $3 for hauling. The chief interest in this chrome deposit lies in the fact that it is within easy access of a large city, and if the mines hold out it may compete largely with other deposits less favorably located. Mr. H. H. Pitcher states that the ore yields 47 to 51 per cent. chromic acid.

From the deposits in Placer county 750 tons were shipped to the East, some of it coming by rail overland, more going via the Isthmus. About 600 tons were extracted from the San Luis Obispo mines during 1885. More than half of this was taken from the Pick and Shovel mine, and the balance from numerous small deposits in the vicinity. These deposits, which are located on the Sierra Santa Lucia, are much mixed with soil and gravel, and being scattered over a consid erable area, afford only a precarious living for some scores of men. The Pick and Shovel mine has been opened by a number of tunnels, one of which is 600 feet in length. Besides these tunnels numerous drifts and chambers have been excavated in search of ore which occurs,

as usual, irregularly in pockets containing from a few hundred pounds to many tons. The containing rock is serpentine, much broken up, and easily excavated. No ore is saved which assays less than 40 to 45 per cent. chromic acid. The cost of extracting the ore and delivering it at its final destination is as follows: Cost of ore at the mouth of the mine, $6.50 per ton; hauling by teams to the railroad depot in San Luis Obispo, $2 per ton; loading on cars, 20 cents per ton; freight to San Francisco, $4.50 per ton; add cost of further transportation to Philadelphia, insurance, commissions, weighing, and shrinkage, and the cost in Philadelphia is $26 per long ton. As these deposits appear to be extensive it is probable that they will be mined for a long time even at the present rates, for there is a considerable population in that section of California content to work for moderate wages while partly engaged also in farming.

The mines of Del Norte county furnished 850 tons of chrome ore during 1885. These mines are owned and worked by the Tysons, of Baltimore, who have equipped them very thoroughly, several miles of railroad being included in the plant.

At Soldiers' Delight, Maryland, chrome ore was mined to the extent of 100 tons.

*Production.*—The amount of chrome ore used in the United States during 1885 was larger than that of the previous year, on account of increased capacity in the Philadelphia works. This might have caused increased production of ore in California but for importations from Russia and Turkey. The ore produced amounted to 2,700 tons, of which 750 tons came from Placer county; 600 from San Luis Obispo; 400 from Livermore, Alameda county; 850 from Del Norte county; and 100 tons from Baltimore county, Maryland. A summary of the production for the past four years is given below.

*Production of chrome ore.*

| Years. | Tons of 2,240 pounds. | Value in California. |
|---|---|---|
| 1882 | 2,500 | $50,000 |
| 1883 | 3,000 | 60,000 |
| 1884 | 2,000 | 35,000 |
| 1885 | 2,700 | 40,000 |

*Price.*—The price of chrome ore varies according to the cost of transportation to a manufacturing center, so that no spot value can be given for it. In San Francisco it is worth about $15 per long ton, but this price is at the mercy of far-distant consumers. It is subject to all the fluctuations in the value of imported ores from Russia and Turkey. The price of ore delivered in Philadelphia or Baltimore was $26 during 1885. The price of potassium bichromate fell from 10½ cents per pound, in 1884, to 9⅞ cents in 1885.

*Utilization.*—Chrome iron ore is used for making chrome steel, sodium bichromate, and potassium bichromate. The amount of ore used for chrome steel is still about 50 tons a year. The manufacture of sodium bichromate increases in proportion as prejudice is removed. It has been imported from Germany; but in 1885, 500 tons made in Baltimore stopped the importation. It is probable that in future years potassium bichromate will be made from sodium bichromate, which involves less costly materials in its manufacture. The manufacture of potassium bichromate was increased in Philadelphia to about 900 tons, making the total production for the country about 2,000 short tons. Several patents for manufacturing ammonium bichromate have been taken out lately, and it has been made at the Baltimore works. The production since 1882 may be compared in the following table:

*Production of potassium and sodium bichromate.*

| Years. | Potassium bichromate. | Sodium bichromate. |
|---|---|---|
| | *Short tons.* | *Short tons.* |
| 1882 | 1,000 | ..... |
| 1883 | 1,000 | ..... |
| 1884 | 1,250 | ..... |
| 1885 | 2,000 | 500 |

*Imports.*—The imports were larger than usual. They were principally from Russia and Asia Minor. The amounts are given below:

*Chromate and bichromate of potash and chromic acid imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Chromate and bichromate of potash. | | Chromic acid. | | Chrome ore. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Long tons.* | | |
| 1867 | 875,205 | $88,787 | ..... | ..... | (*a*) | ..... | $88,787 |
| 1868 | 777,855 | 68,634 | ..... | ..... | ..... | ..... | 68,634 |
| 1869 | 877,432 | 78,288 | ..... | $3 | ..... | ..... | 78,291 |
| 1870 | 1,235,946 | 127,333 | ..... | 8 | ..... | ..... | 127,341 |
| 1871 | 2,170,473 | 223,529 | ..... | 5 | ..... | ..... | 223,534 |
| 1872 | 1,174,274 | 220,111 | 514 | 49 | ..... | ..... | 220,160 |
| 1873 | 1,121,357 | 178,472 | 922 | 276 | ..... | ..... | 178,748 |
| 1874 | 1,387,051 | 218,517 | 44 | 13 | ..... | ..... | 218,530 |
| 1875 | 1,417,812 | 183,424 | 45 | 22 | ..... | ..... | 183,446 |
| 1876 | 1,665,011 | 175,795 | 120 | 45 | ..... | ..... | 175,840 |
| 1877 | 2,471,669 | 264,392 | 13 | 10 | ..... | ..... | 264,402 |
| 1878 | 1,929,670 | 211,136 | 32 | 35 | ..... | ..... | 211,171 |
| 1879 | 2,624,403 | 221,151 | ..... | ..... | ..... | ..... | 221,151 |
| 1880 | 3,505,740 | 350,279 | 5 | 3 | ..... | ..... | 350,282 |
| 1881 | 4,404,237 | 402,088 | 124 | 89 | ..... | ..... | 402,177 |
| 1882 | 2,449,875 | 261,006 | 52 | 42 | ..... | ..... | 261,048 |
| 1883 | 1,990,140 | 208,681 | 290 | 338 | ..... | ..... | 209,019 |
| 1884 | 2,593,115 | 210,677 | ..... | 120 | ..... | ..... | 210,797 |
| 1885 | 1,448,539 | 92,556 | ..... | 39 | (*b*)2,000 | $55,000 | 147,595 |

*a* Not specified. *b* Commercial estimate.

*Exports.*—No exports of ore were reported during 1885. Formerly ore was exported in considerable quantity to England and Scotland, according to the following table:

*Value of chrome ores exported from the United States,* 1864 *to* 1883, *inclusive.*

| Fiscal years ending June 30— | Value. |
|---|---|
| 1864 | $39,585 |
| 1865 | 19,078 |
| 1873 | 2,080 |
| 1874 | 4,288 |
| 1880 | 7,540 |
| 1882 | 1,548 |
| 1883 | 2,905 |
| 1884 | (*a*) |
| 1885 | (*a*) |

*a* None reported.

# COBALT.

By David T. Day.

During 1885 the yield of cobalt increased by the development of the industry of the West. The mines of the Cottonwood district in Nevada, referred to in the last report, have been opened and worked upon an industrial scale. These mines are located in Churchill county, Nevada, in the Table Mountain range, about 45 miles southeast from Lovelock station on the Central Pacific railroad. The region is described by its discoverer, Mr. George Lovelock, as volcanic; the cobalt lies in chimneys and deposits in a mineral belt or ledge of varying width with walls of granite and porphyry. The ledge matter is an aluminous rock impregnated with iron oxides and iron pyrites; the latter also contains traces of cobalt and nickel. The ore deposits vary in size, some being very extensive, but no ores have been found outside the ledge. There are many cobalt and nickel minerals, but the bulk of the ore is black cobalt or "cobaltite," a compound of cobalt, arsenic, and sulphur, which should contain 35.5 per cent. cobalt, but always contains less since part is replaced by varying proportions of nickel, iron, and manganese, and occasionally by antimony. The average character of the ore is represented in the following analysis:

*Analysis of cobaltite from Lovelock mines, Nevada.*

| | Per cent. |
|---|---|
| Cobalt | 17.30 |
| Nickel | 13.62 |
| Iron | 8.65 |
| Manganese | Trace. |
| Arsenic | 39.37 |
| Sulphur | 16.72 |
| Silica | 4.02 |
| Loss | .32 |
| Total | 100.00 |

Erythrite, or "cobalt bloom," and smaltite also frequently occur in the ore. There is also a peculiar substance, very soft and black, having the appearance of lampblack, which seems to be what is commonly

known as "earthy ore of cobalt;" its composition is given by the following analysis:

*Analysis of earthy cobalt from Lovelock mines, Nevada.*

| | Per cent. |
|---|---|
| Cobalt | 29.03 |
| Nickel | 19.13 |
| Manganese | 22.82 |
| Iron | 6.23 |
| Oxygen | 18.20 |
| Silica | 4.32 |
| Sulphur | Trace. |
| Arsenic | Trace. |
| Loss | .27 |
| Total | 100.00 |

Sometimes the oxygen is partly replaced by sulphur and arsenic, and cobalt and nickel by iron or manganese. A peculiar feature of this ore is that immediately upon exposure to the atmosphere it becomes heated from absorption of oxygen. The cobalt bloom is also quite rich in cobalt.

*Analysis of cobalt bloom from Lovelock mines, Nevada.*

| | Per cent. |
|---|---|
| Cobalt | 23.26 |
| Nickel | 4.38 |
| Iron | 1.28 |
| Arsenic and oxygen | 54.45 |
| Silica | 2.90 |
| Water | 13.02 |
| Loss | .71 |
| Total | 100.00 |

Since the first opening of the mines in 1883, about 200 tons of ore have been shipped for reduction to England, of which 90 tons were shipped during 1885. The product of 1886 will probably exceed that of any previous year. The general average of the 200 tons shipped to England was said to have been 12 per cent. nickel and 14 per cent. cobalt. The method of working the ore has been to render it as free from gangue as possible, shipping the high-grade ore to England and retaining the low-grade ore at the mines for future treatment. At present there are no facilities for treating the ores at the mines. The erection of a furnace is contemplated, to reduce it to an arsenical speiss. Upon the erection of reduction works for the low-grade ores, the product will be greatly increased.

Great improvement in the production of cobalt has resulted at Mine La Motté, Missouri, from the process of working the ores into a speiss by the addition of arsenic, an improvement introduced by Mr. James W. Neill, E. M. This process was described in the report of 1883 and and 1884. It was then in the experimental stage, but has since proved signally successful, both financially and otherwise, and is now the stand-

ard method. The speiss now carries 16 per cent. nickel and cobalt, of which 8 per cent. is cobalt. Formerly the mattes contained only half as much cobalt as nickel. The production of nickel and cobalt has increased at this place.

At the Lancaster Gap nickel mine, in Lancaster county, Pennsylvania, cobalt is found as a very small percentage of the ore, but is regularly saved when working out the nickel at Mr. Joseph Wharton's works in Camden, New Jersey, resulting in a considerable production of cobalt oxide; in fact cobalt oxide is not produced elsewhere in the United States. The product of Mine La Motte, Missouri, and that of Nevada is shipped to England or Germany either in the form of speiss or of crude ore.

Arseniate of cobalt has been found in the Kelsey mine at Compton, Los Angeles county, California. Prof. William P. Blake obtained a specimen described by him as consisting of minute mammillary incrustations, showing, when broken, radial aggregations of silky, fibrous crystals. It is of a rosy-red color, also peach-blossom red. It occurs also in massive earthy aggregations, of small fibrous crystals of a rose-pink color. It is associated with an ore of silver and cobalt in dark-colored earthy masses. How much of this mineral exists at the above locality has not been ascertained, no work directed to that end having been done, though the samples obtained are said to have been of good quality.

*Production.*—Cobalt ores are changed into cobalt oxide before use, but this is only done in this country with the ore from the Lancaster Gap mine, at the American Nickel Works, Camden, New Jersey, where 8,423 pounds of cobalt oxide were made in 1885. Besides this, 90 long tons of ore, containing 14 per cent. cobalt, were exported from Nevada; this would yield 40,000 pounds of cobalt oxide. Further, 90 short tons of cobalt and nickel speiss were also exported. This speiss contained 8 per cent. cobalt, or enough to yield 20,300 pounds of cobalt oxide. Thus the actual production of cobalt in various forms was equivalent to 68,723 pounds of cobalt oxide. This serves to show the increase over previous years when the production was practically limited to the Pennsylvania mine.

*Production of cobalt oxide in the United States.*

| Years. | Pounds. | Years. | Pounds. |
|---|---|---|---|
| 1869 | 811 | 1878 | 4,508 |
| 1870 | 3,854 | 1879 | 4,376 |
| 1871 | 5,086 | 1880 | 7,251 |
| 1872 | 5,749 | 1881 | 8,280 |
| 1873 | 5,128 | 1882 | 11,653 |
| 1874 | 4,145 | 1883 | 1,096 |
| 1875 | 3,441 | 1884 | 2,000 |
| 1876 | 5,162 | 1885 | 8,423 |
| 1877 | 7,328 | | |

While the above table represents practically all the cobalt oxide produced in former years, it no longer represents the total cobalt of all present mines. The entire production for 1885 and its value is given below:

*Total production of cobalt ores and oxide during* 1885.

| | Pounds. | Value. |
|---|---|---|
| Cobalt oxide | 8,423 | $19,373 |
| Cobalt ore from Nevada | 201,600 | 31,500 |
| Cobalt speiss from Mine La Motte | 180,000 | 14,500 |
| Total value | | 65,373 |

*Value.*—During 1885 the price of cobalt oxide fell from $2.55 per pound, in January, to $2.25 at the close of the year, averaging $2.30. The ore produced in Nevada should be worth, according to its analysis, about $35 per ton, delivered in San Francisco, although this price includes the value of the nickel also contained in the ore. The speiss is worth from $1 to $1.25 for every pound of cobalt in it. This makes the whole sum realized by cobalt mining $65,373. From this it is easily seen that the influence of the Nevada ores is being felt to a considerable extent.

*Imports.*—The cobalt oxide made at the American Nickel Works in Camden, New Jersey, is limited and does not supply the demand. It is therefore imported regularly from England and Germany, the imported material finding a ready sale from the habit of many consumers, of using only foreign oxide. However well this prejudice may have been founded on the superior quality of imported oxide in former days, it is stated on good authority that cobalt oxide of American make is, as a general rule, better than the greater portion of that imported; and the only foreign variety which can claim greater excellence is that manufactured by the Royal Saxon Works, and which is said to be practically pure. This has but a limited sale and would only be used in fine decorative work on porcelain, such as that produced at the Royal Dresden and Sevres works. The importations since 1868 are given below. It should be stated that an unknown proportion of that imported as "cobalt ore" contains arsenic and is used for fly papers, and hence has no significance as regards its cobalt.

*Cobalt oxide and ore imported and entered for consumption in the United States, 1868 to 1885, inclusive.*

| Fiscal years ending June 30— | Oxide.(a) | | Ore.(b) | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | |
| 1868 | ..... | $7,208 | ..... | ..... | $7,208 |
| 1869 | ..... | 2,330 | ..... | ..... | 2,330 |
| 1870 | ..... | 5,019 | ..... | ..... | 5,019 |
| 1871 | ..... | 2,766 | ..... | ..... | 2,766 |
| 1872 | ..... | 1,920 | ..... | $72 | 1,992 |
| 1873 | 1,480 | 4,714 | 9,769 | 920 | 5,634 |
| 1874 | 1,404 | 5,500 | 3,798 | 612 | 6,112 |
| 1875 | 678 | 2,604 | 5,355 | 659 | 3,263 |
| 1876 | 4,440 | 11,180 | 6,968 | 962 | 12,142 |
| 1877 | 19,752 | 11,056 | 18,377 | 2,390 | 13,446 |
| 1878 | 2,860 | 8,693 | 20 | 1 | 8,694 |
| 1879 | 7,531 | 15,208 | ..... | ..... | 15,208 |
| 1880 | 9,819 | 18,457 | 2,424 | 108 | 18,565 |
| 1881 | 21,844 | 13,837 | ..... | ..... | 13,837 |
| 1882 | 17,758 | 12,764 | 3,102 | 367 | 13,131 |
| 1883 | 13,067 | 22,323 | ..... | ..... | 22,323 |
| 1884 | 25,963 | 43,611 | ..... | ..... | 43,611 |
| 1885 | 16,162 | 28,138 | ..... | ..... | 28,138 |

*a* Not enumerated until 1868. *b* Not enumerated until 1872.

The following table is interesting for comparing the American product with that of another country where the cobalt interests are large:

*Production of cobalt and nickel in Hungary from 1864 to 1883, inclusive.*

| Years. | Metric tons. | Years. | Metric tons. |
|---|---|---|---|
| 1864 | 620 | 1874 | 250 |
| 1865 | 570 | 1875 | 240 |
| 1866 | 430 | 1876 | 50 |
| 1867 | 650 | 1877 | 460 |
| 1868 | 530 | 1878 | 160 |
| 1869 | 570 | 1879 | 350 |
| 1870 | 440 | 1880 | 160 |
| 1871 | 450 | 1881 | 140 |
| 1872 | 380 | 1882 | 180 |
| 1873 | 390 | 1883 | 150 |

*Utilization.*—In addition to the ordinary use of cobalt oxide as a pigment, the use of metallic cobalt in certain alloys is increasing. It has been shown that an alloy, in which iron is the principal metal, can be made malleable and at the same time sufficiently fusible for casting by the addition of cobalt or nickel, or both. Another useful alloy consists of equal parts of cobalt and copper. It is valuable because easily worked, and yet of very great tensile strength.

# TUNGSTEN.

By David T. Day.

Several inquiries were made at the Lane and Booth mines at Munroe, Connecticut, for ores of tungsten to be used in hardening steel and for producing certain tungstates for use as pigments. No tungsten ores were mined, but at the close of the year the Booth mine was about to be put in operation again, solely for obtaining the tungsten ores.

Examples were given in the report for 1882 of the conflicting statements concerning the value of tungsten for hardening steel. The key to this question was furnished during the past year by L. Schneider, who showed in a paper in *Dingler's Polytechnisches Journal*, vol. 256, page 509, that when tungsten is added to iron containing considerable carbon (2 to 3 per cent.) it yields, on cooling, microscopic crystals containing about 60 per cent. tungsten. These are very hard and probably give the hardness to tungsten steel. If, however, they are not formed, and the tungsten remains distributed through the mass in an amorphous state, the steel is not hardened. But the crystals are only formed when the steel contains much carbon; hence it is not always possible to produce hard tungsten steel, and it will usually be brittle. Since the hard crystals are only mixed mechanically through the steel, it will require a considerable percentage of tungsten to produce much hardening. It has been shown also that iron alloyed with tungsten withstands the rusting action of the air better than ordinary iron or steel.

# PLATINUM AND IRIDIUM.

It is claimed by Mr. J. H. Fisk, of Portland, Oregon, that 100 ounces of crude platinum sand were produced near Randolph at the mouth of the Coynill river, in Coos county, Oregon, in connection with gold washings. In addition to this, enough crude platinum was saved by gold miners in California to make the total production of platinum sand for the year 250 troy ounces, valued at $187.50. This is in addition to the platinum in iridosmine, for which there is a regular demand to the extent of 300 ounces annually. It is probable that much platinum which is now wasted every year would be saved if a refinery for the metal was established in this country.

*New localities.*—Platinum and iridium occur together in many of the gold mines of the Pacific coast. In addition to the localities mentioned in the last report platinum has been found in notable proportions in slate at a point known as McKenzie's Bridge, on the McKenzie river, Lane county, Oregon. It is also found in limited amount in all the black sand mines along the coast north as far as Gray's Harbor, in Wyoming Territory, and in the gold mines on the Colville Indian reservation. Mr. Fisk states that he has just received a package of platinum dust from Granite creek, British Columbia. No new occurrences of iridosmine have been noted during the year. It should be stated, however, that the crude platinum from Oregon contains iridosmine, according to the following analysis by Mr. J. H. Fisk:

*Analysis of crude platinum from Oregon.*

| | Per cent. |
|---|---|
| Platinum | 52.00 |
| Gold | .35 |
| Iridosmine | 37.50 |
| Iron | 5.00 |
| Copper | 2.40 |
| Sand | 2.50 |
| Total | 99.75 |

*Foreign sources.*—The principal supply of platinum still comes from the Russian mines in the Ural mountains; this is refined chiefly in England. The production of these mines is well described in an article

in the *Russkie Wedomosti*, of which the following is condensed from the *Chemiker Zeitung:*

The difficulties in manufacturing platinum which have existed till lately have now been almost entirely overcome. Although the platinum utensils exhibited at the last Paris exposition came from foreign, particularly English, workshops, yet the increase in the use of the metal was very evident. In the Moscow exhibition the production of platinum was represented by only two Russian firms. P. P. Demidow, prince of San Donato, exhibited native platinum and platinum plate. In 1875 the firm of Kolbe & Lindfors was established in St. Petersburg to manufacture platinum utensils of all kinds, but their ware was not equal to the English. The firm, with fifteen to twenty workmen, produced platinum ware to the amount of 300,000 rubles, which was used principally in Russia. For the last sixty years the production of platinum has been limited to districts of Goroblogodat and Nishni-Tagilsk. Grains of platinum are found in other districts, but the mining of them has been given up entirely. The following is a table of production from 1827 to 1881, inclusive:

*Production of platinum ores in Russia.*

| Years. | Pounds avoirdupois. | Years. | Pounds avoirdupois. |
|---|---|---|---|
| Previous to 1827 | 600 | 1870 | 3,864 |
| 1827 to 1842, inclusive | 54,000 | 1871 | 4,096 |
| 1843 | 7,560 | 1872 | 3,044 |
| 1844 to 1861, inclusive | 24,480 | 1873 | 3,146 |
| 1862 | 5,113 | 1874 | 3,986 |
| 1863 | 1,082 | 1875 | 3,080 |
| 1864 | 872 | 1876 | 3,146 |
| 1865 | 4,997 | 1877 | 3,440 |
| 1866 | | 1878 | 4,128 |
| 1867 | | 1879 | 4,520 |
| 1868 | 3,570 | 1880 | 5,876 |
| 1869 | | 1881 | 5,956 |

It is seen that the production in the last few years has increased markedly on account of greater inquiry for the wares, and the price has risen also. The 5,956 pounds produced in 1881, came largely from Nishni-Tagilsk (2,456 pounds). Kresto Wosdwishensk produced 886 pounds; Werchotursk 1,508 pounds and 1,048 pounds mixed with gold; and Bogoslaw 752 pounds. It is expected the production will soon extend to other districts. Until 1877 the production was almost entirely by private parties. In 1861 the government only mined 128 pounds. The proportion in subsequent years is not given.

*Imports.*—The platinum ware sold in this country is principally made from "flat stock," that is, platinum in the form of sheets or thick wire imported from England. Manufactured utensils are occasionally imported from France. The following imports, therefore, represent the total consumption of platinum in this country, for the slight domestic product is exported to England to be refined.

*Platinum imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Manufactured. | Unmanufactured. | | Vases or retorts, etc. |
|---|---|---|---|---|
| | | Quantity. | Value. | |
| | | *Pounds.* | | |
| 1867 | $456 | | | |
| 1868 | 290 | | $95,208 | $20,274 |
| 1869 | 184 | | 80,014 | 22,004 |
| 1870 | 648 | | 99,984 | 16,294 |
| 1871 | 48 | | 108,244 | 22,470 |
| 1872 | 310 | | 91,472 | 21,816 |
| 1873 | 43 | | 90,771 | 9 |
| 1874 | 143 | | 123,293 | 59,698 |
| 1875 | 173 | | 141,188 | 18,682 |
| 1876 | 6 | | 141,207 | 7,421 |
| 1877 | 11 | | 81,925 | 18,611 |
| 1878 | 241 | | 120,121 | 50,133 |
| 1879 | 73 | | 166,178 | 34,209 |
| 1880 | 964 | | 217,144 | 41,827 |
| 1881 | 290 | | 273,343 | 21,292 |
| 1882 | 1,731 | 3,125.60 | 285,731 | 48,452 |
| 1883 | 4 | 3,104.15 | 298,799 | 92,967 |
| 1884 | None. | 2,846.00 | 289,898 | 83,112 |
| 1885 | 3 | 2,612.34 | 285,239 | 17,473 |

*Exports.*—There is a demand from England for "scrap" platinum to which the United States contributes by exporting some worn-out utensils to be repaired and reimported. A portion of these exports also go to France. The following table gives the exports from 1880 to 1885, inclusive:

*Value of platinum exports.*

| Fiscal years ending June 30— | Unmanufactured. | Manufactured. | Old platinum. |
|---|---|---|---|
| 1880 | | | $600 |
| 1881 | | | 4,222 |
| 1882 | | $19,244 | |
| 1883 | $6,250 | 21,600 | |
| 1884 | | 18,587 | 1,130 |
| 1885 | | | 7,000 |

In addition to a small domestic production of iridosmine, the following amounts of iridium were imported at a value of $20 per troy ounce for the American Iridium Company for uses which were described in detail in the last report:

*Iridium imported and entered for consumption in the United States, 1873 to 1885, inclusive.*

| Fiscal years ending June 30— | Value. |
|---|---|
| 1873 | $429 |
| 1874 | 275 |
| 1875 | 500 |
| 1876 | 180 |
| 1877 | 311 |
| 1879 | 425 |
| 1881 | 1,730 |
| 1882 | 7,307 |
| 1883 | 495 |
| 1884 | (*a*) |
| 1885 | 5,852 |

*a* None reported.

# TIN.

*American tin.*—At the close of 1884 there was a prospect that the production of American tin might become an established industry in the year to follow. The purchase of the Etta mine in the Black Hills of Dakota by eastern capitalists, and plans for a concentrating plant, contributed largely to this opinion and led to much prospecting throughout the region from which tin has been reported. But the entire year passed by in this preparatory work without the production of tin, except experimentally. A large mill, capable of handling 100 tons of ore daily, was constructed at the Etta mine, and at the close of the year the outlook justified the very sanguine reports of the local press, but in March of 1886 the actual tests of the ore began by means of the mill. According to the most reliable statements the mill consumed in all about 400 tons of ore, containing perhaps 7 tons of tin. Much of the ore milled was scarcely more than waste rock, which did not yield one-half per cent. of tin. It is very probable that this is not a fair test of the mine, which needs further opening, and it was for this purpose that the mill stopped operations in May, 1886.

The prospecting has been very active, both in the Harney Peak region and near Custer City, resulting in the addition of a large number of new claims, all of which await the tests of concentration on a large scale. This prospecting has been limited to the neighborhood of well-known claims, so that the general field has not been extended nor any accurate information obtained beyond the scope of the last report.

In the Nigger Hill district, Wyoming, many new claims have been worked over by engineers, and some have proved promising as far as they have been developed. The Molitor-Trebor group of claims has shown the following percentage yield of tin:

*Assays of tin ore from Wyoming.*

| | Per cent. |
|---|---|
| Swansea, Nos. 3 and 4 | 2 |
| Grand Deposit | 1 |
| Connection | $1\frac{8}{10}$ |
| Congress | $\frac{1}{8}$ |
| Valley View | $3\frac{1}{4}$ |
| Chicago | $\frac{1}{4}$ |
| Montana | $\frac{1}{8}$ |
| November | $\frac{3}{4}$ |
| Yankee | $1\frac{3}{10}$ |
| Yankee, sample No. 2 | $\frac{1}{4}$ |
| Uncle Sam | $5\frac{26}{100}$ |
| Uncle Sam, sample No. 2 | $5\frac{7}{10}$ |
| Grey Eagle | $2\frac{3}{10}$ |

These claims are located on three veins, one of which has been traced 5,600 feet. This has been developed by an open cut 35 feet long, crossing the vein at right angles, and by a shaft about 10 feet deep. The assay of specimens from this claim shows 5 per cent. of tin; the claim is promising. The development of the other claims has been very slight. The Montana Tin Mining company is actively pushing a claim 12 miles east of Dillon in that State.

Mr. Hotchkiss has recently visited and personally examined the tin-bearing region near the head of Irish creek, Rockbridge county, Virginia, and submitted the following report of his observations and conclusions to the president of the Lexington Tin company.

"The tin field is located in a small area, in the eastern part of Rockbridge county, Virginia. The region is very accessible from nearly all directions.

"The Irish Creek area within which tin ore has been found is about 3 miles wide from northwest to southeast, and about 4 miles long from northeast to southwest, and therefore embraces some 12 square miles of territory. It is near three lines of railways. To the Shenandoah Valley railroad the air-line distance is but 3 miles, and the distance by the valley of Irish creek, following that stream, is about 10 miles. To the Valley branch of the Baltimore and Ohio railroad the air-line distance is 6½ miles; and to the Richmond and Allegheny railway 11 miles.

"The tin ore of this region is found in the form of crystals, threads, or strings, and in masses of varying size, disseminated in fissure veins traversing, in all directions, the granitic and other Archæan rocks that here constitute the crest and the immediate westerly slopes of the Blue Ridge, and that disappear beneath the Potsdam rocks 1 or 2 miles to the northwest of the tin-bearing field.

"The tests to prove the existence of these ores were made by sinking, driving, or cutting pits, trenches, shafts or tunnels, at the points indicated, as hereinafter described in detail, mainly in a territory about 1½ miles long and 1¼ miles wide. At other points, outside of this territory, the existence of tin ore has been proved. The character of these test works and of the ore found at each, and therefore the present condition of information about these tin ores, based on what has been actually ascertained about them, can best be learned by a brief statement about each of these trial works.

"No. 1. This is known as the "Cash No. 1 Mine," as it is at the point on the Cash land where tin ore was first found in this region. This is an open cut about 60 feet long and from 3 to 10 feet deep, driven into the base of the spur of Cash mountain a few feet above the level of Painter branch. The tin-bearing vein here has an average thickness of about 8¼ inches; this consists of tin-stone disseminated in small grains and small pockety masses throughout a gangue of quartzose and mica-

ceous rock that can be easily mined and crushed, and next to the wall, a persistent vein of solid tin-stone, or cassiterite, that averages one inch in thickness, and is sometimes 6 inches thick. Several branchings of veins from the main one, penetrating the crevices of the adjacent rocks, have also been discovered here. Portions of this large vein are occupied by masses of quartz rock.

"Professor Campbell sampled 72 inches of the thickness of this vein, including the wall rock involved with the ore, and found it to contain 66 pounds of metallic tin to the ton. Mr. McCreath analyzed a sample of this ore selected by Mr. Rittenhouse 'representing all grades, from pure tin crystals to quartz and rock containing little or no tin,' and found in it an average of 3.160 per cent. of metallic tin. The cassiterite will yield, by itself, from 65 to 70 per cent. of metallic tin.

"No. 2 embraces four openings; the second opening is a shaft 40 feet deep, said to include a vein of tin ore that is 36 inches thick at the surface and 120 inches thick in the bottom of the shaft where sinking was suspended. Mr. Cabell Whitehead found in an average sample of the ore of this vein, representing its whole thickness, after repeated assays, an average of 5 per cent. of metallic tin, or from 125 to 130 pounds of tin to the ton of ore. Professor Campbell made the percentage larger.

"About 3,000 pounds of the ore from this shaft were sent to England as a trial lot; the purchaser reported a considerable yield of metallic tin. I requested Mr. Massie, who selected the ore for that shipment, to sample the ore lying scattered around this shaft for me, so as to give me what would fairly represent the ore that was shipped to England. I witnessed the sampling, and am satisfied that it was fairly done. This sample of several pieces I submitted to Dr. Frank W. Traphagen, analytical and consulting chemist of the Staunton Male Academy, and he found in it, after repeating his analysis, 17.54 per cent. of binoxide of tin, or 13.79 per cent. of metallic tin. Nodules of cassiterite, from small sizes up to some 12 inches in diameter, have been found in this vein; there is no question about its richness. This shaft is on the slope of Painter mountain, and more than 400 feet above the level of Irish creek at the foot of the mountain to the north. No. 2*a* is a pit uncovering a large bowlder of quartz that is veined with crystals of tinstone; that will probably yield as well as the vein at the shaft, or No. 2, which is 70 feet above this in altitude, the intermediate ground being strewn with tin ore. No. 2*b* is an open drift, at a level 90 feet below No. 2, cut for 60 feet into the slope of the mountain, ending there about 15 feet deep, where a vein of tin ore, apparently averaging with that at No. 2, had been cut and found 108 inches thick. No. 2*c* is a trench on a tin-ore vein of about the same character as the preceding.

"No. 3 is some 500 feet above the level of the creek opposite, is a long trench, about 6 feet deep, exposing some 10 feet of a vein of tin stone

that is 48 inches thick. An average sample of this ore, assayed by Prof. H. D. Campbell, yielded 0.292 per cent. of metallic tin; a sample assayed by Prof. M. B. Hardin, at Virginia Male Institute, yielded 0.41 per cent. A quartz vein is exposed near this, resembling the one near No. 2. Traces of ore extend from this to No. 2.

"No. 4 is a shallow cut, about 1 foot deep, exposing a tin vein 12 inches thick that yielded 0.19 per cent. when assayed by Prof. M. B. Hardin.

"No. 5 consists of three pits connected by a trench. The tin vein in the middle pit is 18 inches thick; samples from this yielded 5 per cent. metallic tin in an analysis by Professor Hardin. A sample from the upper cut, or pit, an average of the ore from 6 feet of length of vein, gave 0.799 per cent. of binoxide of tin on analysis by Prof. H. D. Campbell. In the upper cut the vein is one-half inch thick at the depth of 10 feet; it becomes thicker as it goes down, and will average 7 inches. A good many crystals of tinstone are found here."

No. 6 is a pit exposing a vein 12 inches thick; it widens in going down. An average sample yielded 0.28 per cent. of metallic tin as analyzed by Professor Hardin.

No. 7 is a pit showing a vein 18 inches thick; it is much like No. 6, but poorer.

No. 8 is a pit showing a vein 36 inches thick of lean ore.

No. 9 is a pit showing vein 4 inches thick; ore not assayed.

No. 10 is a shaft 40 feet deep, sunk on a vein 36 inches thick. A sample taken at the depth of 3 feet, before the shaft was sunk, representing an average of the exposed vein, yielded 1.12 per cent. of metallic tin to an assay by Dr. Dabney, of North Carolina; at a depth of 10 feet, 2 per cent. of cassiterite was found in an assay of the vein by Mr. A. D. Robertson. This vein is in trap rock. Three or four threads of ore come together in the bottom of the shaft.

No. 11 is a pit exposing a vein 43 inches thick containing a trace of tin.

No. 12 exposes a vein 12 inches thick containing a trace of tin.

No. 13 exposes a vein 8 inches thick containing a trace of tin.

No. 14 is a vein 48 inches thick of lean ore between trap and granite.

No. 15 is a trench exposing a 6-inch vein in quartz in which crystals of tinstone are found.

No. 16 is a tunnel in rotten granite 30 feet long, cutting a vein of lean ore from 3 to 12 inches thick.

Nos. 17, 18, 19, and 20 are pits exposing a 6-inch vein of lean ore.

No. 21 is a tunnel driven in rotten granite some 60 feet along an 18-inch vein. Professor Hardin assayed picked samples from this vein and obtained 3¼ per cent. of metallic tin. Professor Campbell assayed a sample, averaging 25 feet of the length of the vein, and obtained 0.582 per cent. of metallic tin. In a pit sunk above this tunnel this vein is also 18 inches thick.

No. 22 is a vein exposed by the roadside that is from 3 to 4 inches thick in solid rock; it is regarded as an offshoot thread from No. 21.

No. 23 is a pit and a short tunnel on a lean 10-inch vein.

No. 24 consists of two parallel veins about 10 feet apart, from 3 to 6 inches thick, which meet No. 25; this ore assays next to that of No. 21.

No. 25 is a vein about 12 inches thick, which crosses and dips towards No. 24; it assays about 0.25 per cent.

No. 26 is a tunnel about 30 feet long in a vein 24 inches thick in places; this assays 0.10 per cent.

No. 27 is a pit exposing two parallel veins about 6 feet apart, one 4 to 6 inches and the other 12 inches thick of lean ore.

No. 28 is a pit exposing a 24-inch vein of lean ore.

No. 29 is a drift cut some 30 feet long and over 30 feet deep at the end, exposing a vein of lean ore averaging 24 inches thick. Assays 0.10 per cent. This vein has been exposed for 400 yards, to the top of the mountain, where it is 120 inches thick; in places in the drift below it is 240 inches thick. The tinstone here is associated with quartz and iron pyrites. It is believed that this and Nos. 30, 31, and 32 will finally come together.

No. 30 is a vein 12 inches thick in very hard rock; an assay of a sample gave 1 per cent., but the average will be less.

No. 31 is a vein averaging 24 inches in thickness (36 in places). Professor Hardin obtained 0.17 per cent. of tin from an average of the whole vein. It also carries $1.86 of gold to the ton.

No. 32 is a vein 48 inches thick, averaging in richness between Nos. 30 and 31.

Nos. 33 and 34 are cuts on a quartz and pyrites vein containing traces of tin.

No. 35 is an outcrop of veins from which an 8-inch cubic block of crystals of tin stone was obtained. Not opened as yet.

No. 36 is a quartz vein 60 inches thick that yielded an average of 0.12 per cent. of metallic tin to assay of Mr. A. D. Robertson.

No. 37 is a vein 36 inches thick, on Mount Nettle, some 1,200 feet above Irish creek, in micaceous granite.

No. 38 is a 10-inch quartz vein containing iron pyrites and a trace of tin.

In the above notes the measurements of Messrs. Winslow and Robertson have been accepted and used, and the assays of Messrs. McCreath, Campbell, etc., as reported in published articles and as furnished to Mr. Robertson.

"The forty odd testing pits, trenches, shafts, tunnels, etc., above mentioned, are distributed over a territory nearly 10 miles wide and 4 miles long in the north and middle spurs, Mount Maria, Cash mountain, Painter mountain, Mount Elizabeth, Little Hill and Big Hill, and Mount Nettle, all spurs of the Blue Ridge projecting between the northeasterly and the easterly head branches of Irish creek. In all of

these more or less metallic tin has been found, ranging from "traces" up to 70 per cent. Those that have been assayed may be recapitulated as follows:

No. 1, 0.292 to 65 or 70 per cent., 66 pounds to the ton average.
No. 2, 5 to 13.79 per cent., 125 to 130 pounds to the ton.
No. 3, 0.292 to 0.41 per cent.
No. 4, 0.19 per cent.
No. 5, 0.799; 17.58 pounds of "black" tin to the ton.
No. 6, 0.28 per cent.
No. 10, 1.12 to 2 per cent., 35 pounds of "black" tin to the ton.
No. 21, 0.582 to 3.25 per cent., 18 pounds of "black" tin to the ton.
No. 25, 0.25 per cent.
No. 26, 0.1 per cent.
No. 29, 0.1 per cent.
No. 31, 0.17 per cent. of tin and $1.86 of gold to the ton.
No. 36, 0.12 per cent.

The localities of the above and the per cents. of tin are:

No. 1, on Cash mountain, 31.60 to 70 per cent.
Nos. 2 and 3, on Painter mountain, 0.292, 0.41, 13.70 per cent.
Nos. 4 and 5, on Mount Elizabeth, 0.19, 0.799 per cent.
No. 6, on Little mountain, or hill, 0.28 per cent.
No. 10, on Big Hill, 1.12, 2 per cent.
Nos. 21, 25, 26, 29, and 31, on Mount Maria, 0.17, 0.25, 0.582, 0.1, and 3.25.
No. 36, on North Spur, 0.12 per cent.

"Omitting from the above the deposit on Cash and Painter mountains, assays Nos. 1, 2, and 3, the averages of yields from the other localities do not vary greatly among themselves, showing that these ores range in richness from 0.1 to 3.25 per cent.; the eleven assays of these localities averaging 0.805 per cent., or nearly 18 pounds of "black" tin to the ton. I see no reason why an abundance of ore should not be had from these, Mount Elizabeth, Little mountain, Big Hill, Mount Maria, and North Spur veins, that will yield this average result.

"The assays of the Cash and the Painter mountain ores range in richness from 0.292 to about 70 per cent., making an average for the five given of 23.218 per cent. This is probably too high an average for all the well-picked tin stone that could be obtained from these localities; and yet it would not, in my opinion, be very difficult to obtain from them a large quantity of ore that would run such an average. The prospecting that has been done, the condition of the veins as exposed, and their richness in metallic tin, I think, warrant the conclusion that an abundance of high-grade ore can readily be obtained from these localities.

"While the developments that have been made here are by no means extensive, and are not such as one would like to see, still they cover a very considerable area and fairly well expose the tin veins at moderate depths

from the surface, and so that their character can be seen very well. More than this, the openings that have been made are so located as actually to expose to inspection fully 600 feet of the vertical depth of the tin veins of this region, some of them having been made near the level of Irish creek and others near the top of the spurs more than 600 feet above that level; horizontally these openings are many of them but a short distance apart, consequently it is fair to say that we have here, in this deeply and steeply eroded or naturally trenched region, the equivalent of shafts of varying depths, up to over 600 feet in a level country. For example, numbers 1 and 2 are but 1,600 feet apart horizontally, and yet they are over 300 feet apart vertically. It is considered that from these two and their surroundings there are nearly the same data for conclusion as would be obtained if the shaft at No. 2 were sunk to a depth of 320 feet. The same may be said of the other localities where the tin ore has been exposed. This knowledge has led me to the favorable conclusion above expressed in reference to the quantity and the quality of these ores.

"The geological and mineralogical conditions of the Irish Creek tin-bearing region are similar to, if not even identical with, those of the Cornwall (England) and other noted tin-producing districts. There are the same crystalline and metamorphic rocks, broken, fissured, and faulted by dikes of trap, basalt, and other igneous rocks, thus furnishing similar conditions for the formation of true, profitable, metalliferous, fissure veins, such as are caused by profound movements of the earth's crust—just such veins as those in which stanniferous ores of the Irish Creek district are found.

"The exposure of the Irish Creek tin veins, both natural and artificial, unmistakably leads to the conclusion that these veins compare in general character, extent, thickness, and richness in metallic tin, most favorably with those of the famous Cornwall district of England, while the mining conditions are better. I may add that no region can offer superior advantages for extensive mining and metallurgical operations; the climate is all the year round salubrious and favorable for work; the Blue Ridge proper of Virginia, unlike most mountain chains, is a very garden of fertility and varied productiveness, and the same may be said of Piedmont, Virginia, that flanks it on the east, and of the famous limestone valley that flanks it on the west. The forests of this region can be depended on for charcoal, and it is not far by direct railway to the best metal working and coking coals in the United States."

In conclusion, this report is emphasized by the opinion that this Irish Creek tin-bearing district, as above described, will prove abundantly productive in tin.

*Foreign sources of tin.*—The association of Cornwall, England, with the production of tin, and the enormous manufacture of tin plate in England, have led to popular reference to England as the principal source of that metal by the large majority of people outside of the trade.

although such expressions as "Banca," "Billiton," and "Straits" tin are trade acknowledgments of other important sources which contribute to the world's supply. Any one of these sources contributes as largely as England, and the whole production is derived from New South Wales, Queensland, Tasmania, the Straits Settlements, the Dutch East Indies, as well as from England. Occasional shipments are made also from Spain, Portugal, France, and South America.

The production from these sources is summarized by Messrs. Vivian, Younger and Bond, of London, in the following table:

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| Total exports from Singapore and Penang: | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| To Great Britain, Europe, and America | 11,908 | 11,216 | 12,104 | 17,145 | 17,547 | 17,182 |
| To India and China | 2,855 | 3,519 | 3,870 | 4,161 | 4,920 | 3,887 |
| | 14,763 | 14,735 | 15,974 | 21,306 | 22,467 | 21,069 |
| Total exports from Australia to Europe and America | 9,100 | 10,200 | 10,300 | 10,500 | 8,800 | 8,500 |
| Total production in the United Kingdom | 8,918 | 8,615 | 9,158 | 9,307 | 9,574 | (*a*)9,000 |
| Totals | 32,781 | 33,550 | 35,432 | 41,113 | 40,841 | 38,569 |
| Total visible supply December 31 | 22,248 | 19,241 | 17,924 | 19,263 | 16,774 | 16,116 |

*a* Estimated.

In England the low price of tin at the close of 1884 led to much discussion as to the possibility of reducing the cost of producing tin in Cornwall, and gave rise to a very valuable treatise on the Cornish system of dressing tin ores, by Mr. R. J. Frechville. The main principle in dressing these ores consists in crushing the tin-bearing rock by stamping, and obtaining therefrom 2 to 3 per cent. of cassiterite by washing off the lighter rock with large streams of water. The fact that the settlings from streams so used are sufficient to support plants for working them at intervals between the mines and the mouths of the stream, has given rise to many statements as to the wasteful character of this method of ore dressing, and the following extracts from Mr. Frechville's paper bear on the point and give to those interested in similar systems of mining many interesting facts from Cornwall:

That the loss by the processes to which the "tin stuff" is subjected at the mines is very considerable, is proved by the fact that, during 1884, 1,326 tons of black tin, sold to the smelters for £41,055, were obtained from the tin streams in the parishes of Camborne, Illogan, and Redruth alone, and the dressing operations carried on at Gwithian and Portreath beaches plainly indicate that even then the sands and slimes escaping from the mines were not perfectly untinned.

"Many imagine that the stream works that furnished the above quantity of black tin are all situated on the Red river. This is not the case. There are two separate and distinct rivers fed by the discharge from the dressing floors of two separate and distinct groups of mines. One of these rivers, which is called for the sake of distinction the Redruth river, flows along the southern base and eastern flank of Carn

Brea Hill, passes to the west of Redruth, by the east of the Wheal Agar stamps, and then continues its course northward to the sea at Portreath. The mines that contribute to it are West Basset, Wheal Basset, Wheal Uny, Wheal Agar, etc. During 1884, 172 tons of black tin, which realized £6,039, were obtained from it. The remaining and by far the most important stream, known as the Red river, which I take as an example in working out the problem before me, rises in Bolenowe Moor, to the south of Carn Brea Hill, and runs clear until it is joined by the water from the dressing floors of South and West Frances mines; it then flows northward between Carn Entral and Carn Arthen, through Brea and Tuckingmill to Roscroggan, at which place it turns to the west, and continues on this course through Reskadinnick, Coombe, Menadarva, and Reskajeage to the beach at Gwithian, where it empties into St. Ives bay. As far as Coombe, it forms practically the boundary between Camborne and Illogan parishes. From source to mouth its length is between 7 and 8 miles, and over this distance the various stream works succeed each other almost without intermission, and produced during 1884, 1,154 tons of black tin, which sold for £35,016.

"With respect to the quantity of sands and slimes from which the above amount of black tin was obtained, the following table gives for 1884 the names of the mines that discharged the waste from their dressing floors into the Red river, the number of tons of tin stuff of 21 cwts., dry weight, stamped and dressed at each mine, the black tin obtained therefrom in statute tons, and the value of the same:

*Statistics of mines discharging the waste from their dressing floors into the Red river in 1884.*

| Mines. | Number of tons of "tin stuff" of 21 cwt. each, stamped and dressed. | Black tin obtained, in statute tons. | Value of ore at the mine. |
|---|---|---|---|
| West Basset (old stamps) | 2,000 | 30 | £1,273 |
| West Frances | 9,360 | 394 | 17,849 |
| South Frances | 15,000 | 434 | 19,861 |
| South Condurrow | 23,361 | 546 | 26,032 |
| Wheal Grenville | 19,227 | 463 | 22,174 |
| Cook's Kitchen | 12,312 | 176 | 8,035 |
| Dolcoath | 66,300 | 2,423 | 113,965 |
| South Crofty | 8,673 | 169 | 7,143 |
| East Pool | 45,982 | 1,573 | 69,343 |
| Tincroft | 29,930 | 456 | 19,705 |
| Carn Brea | 44,858 | 464 | 20,247 |
| West Seton | 10,650 | 204 | 9,238 |
| Total | 287,653 | 7,332 | 334,865 |

"It is the custom to reckon the ton of tin stuff as 21 cwts. dry weight; in addition, an allowance for water varying from 1 to 2 cwts. is made, so that the ton of tin stuff delivered to the dresser actually weighs from 22 to 23 cwts. In the assay of the samples, the black tin is calculated for the ton of 20 cwts., and is weighed dry, whereas the dresser returns

the black tin moist, containing, on the average, 7½ per cent. water. All this is so strongly in favor of the dresser that there is no difficulty in understanding how he manages to return as much black tin as the stock book shows, and occasionally even more. Reducing the total number of tons stamped to statute tons, for the sake of dealing with uniform weights, and deducting from these statute tons the black tin obtained at the mines, as well as an estimated amount of 10,000 tons of sand, placed on the burrows at Tincroft, owing to a lack of water to carry it away from the floors, we get 284,703 statute tons as the quantity of sands and slimes that were discharged into the Red river—thus:

287,653 tons of 21 cwts.=302,035 statute tons.
302,035—7,332 —10,000=284,703 statute tons.

Subtracting from these latter figures the 1,154 tons of black tin returned from the Red river, gives 283,549 tons as the quantity of sands and slimes emptied into St. Ives bay. In order to estimate the total contents in black tin of the ore stamped and dressed at the mines, it is necessary to know how much escaped and was irrecoverably lost in these 283,549 tons. To ascertain this, samples of the flow of the river were taken from a point below the last stream works at different dates extending over the whole of 1884. These samples were taken by lowering buckets to the bottom of the stream, instantly pulling them up again, and then allowing the contents ample time to settle before pouring off the water. In this way sixty samples were collected and were assayed by Capt. John Moyle, of South Condurrow mine. These assays gave results varying from a trace up to 2¾ pounds black tin per ton of stuff. A produce of 1½ pounds per ton would be a fair average of the lot, so that the quantity of black tin carried into St. Ives bay by the 283,549 tons of sands and slimes discharged therein by the Red river during 1884 amounted to no less than 190 tons.

"The actual contents in black tin of the 302,035 statute tons of tin stuff stamped and dressed at the mines, as well as its market value, and the average price per ton realized for both mine and stream tin ore can now be computed thus:

*Contents of tin stuff from Red river mine, Cornwall.*

| | Statute tons. | Price. | Average price per ton. |
|---|---|---|---|
| | | | £ s. d. |
| Black tin obtained at the mines | 7,332 | £334,865 | 45 13 5 |
| Black tin obtained from the stream works | 1,154 | 35,016 | 30 6 10 |
| Black tin locked up in 10,000 tons of sand on Tincroft burrows (estimated value at £40 per ton) | 14 | 560 | ..... |
| Black tin finally lost in St. Ives bay (estimated value at average price of stream tin ore) | 190 | 5,765 | ..... |
| Totals | 8,690 | 376,206 | ..... |

From the above, it appears that the tin stuff originally contained 64.44 pounds of black tin per statute ton. Of this amount, 54.37 pounds, or 84.37 per cent., was saved at the mines; 8.55 pounds, or 13.27 per cent., by the stream works; 0.11 pound, or 0.17 per cent., remains locked up in Tincroft burrows; and 1.41 pounds, or 2.19 per cent., was lost in the sea. It must, however, be taken into consideration that the black tin obtained from the stream works is not of the same value as that obtained at the mines. During 1884 the average produce in metal of the latter was 66 per cent., and of the former 53 per cent. only; so that it is more correct to make the above caculations on the basis of the market value of the ore. Thus, of the £376,206 worth of black tin contained in the tin stuff dressed, £334,865, or 89 per cent., is to be credited to the mines; £35,016, or 9.3 per cent., to the stream works; and the remainder, £6,325, or 1.7 per cent., constitutes the loss. All who have a practical knowledge of ore dressing must admit that the saving by the mines of 89 per cent. of the value of the stuff treated is a very good result indeed—in fact, much better than had been anticipated when this inquiry was commenced. Nevertheless, it is believed that it is possible in some slight degree to increase the efficiency of the process.

"*The cost of ore dressing.*—Having gone very carefully into this matter at two of the leading mines, it is found that, including every charge from the time that the tin stuff is delivered to the stamps until the ore is ready to be sent to the smelters, the cost amounts to 5*s.* per ton of tin stuff dressed. This includes a charge for repairing the floors, but not for depreciation in value of machinery. Adding 2*d.* per ton for this item, would make the total cost 5*s.* 2*d.* per ton. This is the weak part of the process. The cost, owing to the large amount of manual labor employed, is too high, and, in these days of improved machinery of all descriptions, should most certainly be reduced. During 1884 the mines that contributed to the Red river employed 4,725 persons; of these,

2,571 worked at the surface and 2,154 underground. Of the surface hands, 75 per cent., or 1,928 persons, were engaged on the dressing floors. Labor is cheap and plentiful in Cornwall, so that there is not the same necessity that exists in some other countries, the United States, for instance, of introducing automatically working machinery; but the employment of such an excessive amount of manual labor is an abuse of the advantages, and not in keeping with the scientific progress of the age.

"The system of dressing is of native growth, and naturally in many ways eminently suitable to local conditions; but it is thought certain details and appliances can be grafted on to it that will tend both to increase its efficiency and diminish its cost. In this connection the following suggestions occur:

"In the first place, as pointed out by Capt. William Rich, in a paper read before the Mining Institute, constant assays should be made by an independent man of the sands and slimes leaving the floors. This would act as a check on the dressers. An abundance of clear water is essential for good dressing; unfortunately the supply is deficient at the richest tin mines. Could it not, however, be supplemented by constructing reservoirs in suitable localities? Blake's stone breakers, although excellent and well-proved machines, are not nearly in such common use in the county as they should be; too much reliance is still placed on the muscular arms of the maidens. There can be no doubt but that great economy in stamping would result from the employment of Husband's oscillating cylinder-stamps.

The treatment of the stamped stuff should invariably be preceded by classification; that is, not only should the slime be separated from the sand, but the latter should be sorted according to the different sizes and weight of the grains. For this purpose funnel or pointed boxes are very suitable; if with an upward current of water, like those in use at Wheal Grenville, so much the better. They can be arranged so that each box delivers a certain size of grains to the buddles or other dressing machines employed, while the slimes flow over the end of the last box, and can be carried directly to the slime dressers or frames. Taking into consideration the fineness to which the stuff is reduced by the stamps, a division into three classes, namely, sands, middle fine sands, and slimes, would be amply sufficient. When the stuff is discharged from the stamps directly into a buddle, as is the practice at many of the mines, much of the slime tin passes to the tail, and not being saved by the subsequent operations to which this is subjected, finds its way into the Red river. As the "strips" that used to be universally used in front of the stamps to a certain extent classified the ore, their abandonment is decidedly a retrograde step in dressing. These "strips" are, however, by no means to be compared in efficiency with the pointed boxes, and besides the stuff deposited in them has to be shoveled out by hand, while from the

pointed boxes it is delivered without expense and at any point required. At all of the mines, separators for classifying the stuff are employed below the slime pits. Ask any of the dressers why they use them, and they will answer, it is because they find it impossible to obtain good results by dressing the sand and slime together; yet to judge by their practice, one would imagine that directly in front of the stamps they believe the laws of specific gravity to be suspended. For the treatment of the coarser sand delivered by the pointed boxes, is recommended the employment of Rittinger's double side blow percussion table, a description and drawings of which are contained in a paper by Mr. Frechville, "On the Mining and Treatment of Gold Ores in the North of Japan," published in volume 75 of the "Minutes of Proceedings of the Institution of Civil Engineers." The table is perfectly automatic in its action, and would give three products, namely, ore fit to be sent to the calciner, ore associated with vein stuff for the pulverizers, and valueless waste. It is the best continuous working machine yet invented for dealing with the coarser portions of stamp work. Borlase's buddle is well adapted for the middle fine sands, and for dressing the slimes the Cornish frame is an excellent appliance, especially when carefully constructed and arranged like those to be seen in the stream works of Mr. John Williams, at Tuckingmill.

A great deal has been said of late years about the wonderful results that would be obtained if jiggers were used in dressing the tin stuff. With the object of ascertaining whether these assertions are well founded, samples of the stuff were taken at several mines just as it passed through the stamp grates, which in each case were of the size known as No. 36, the perforations of which are 0.028 of an inch in diameter. These samples were dried, weighed, and assayed. They were then sifted through a sieve with eighty holes to the linear inch. The portion that remained on the sieve and the portion that passed through were carefully weighed and assayed, the former being assayed without bruising or pulverizing as well as with bruising, the contention being that the extra amount of tin ore washed out after bruising is inclosed in particles of gangue, and would mostly be discharged with the tails of the jigger. As these experiments also throw some light on the disposition of the black tin in the stamped tin stuff, they are given in full in the accompanying table:

| | South Condurrow. | East Pool. | Dolcoath. |
|---|---|---|---|
| Contents in black tin per ton of stuff leaving coffers | 235 pounds. | 45 pounds. | 45 pounds. |
| Percentage of stuff that passed through 80 sieve (*a*) | 61 per cent. | 62 per cent. | 62 per cent. |
| Percentage of stuff that remained on sieve (*b*) | 39 per cent. | 38 per cent. | 38 per cent. |
| Produce per ton in black tin of (*a*) | 330 pounds. | 62 pounds. | 65 pounds. |
| Produce per ton in black tin of (*b*) | 78 pounds. | 25 pounds. | 9 pounds |
| Produce per ton in black tin of (*b*), without bruising | 33 pounds. | 11 pounds. | 3 pounds. |
| Quantity of black tin in each ton of stamped tin stuff locked up in particles of gangue | 45 pounds. | 14 pounds. | 6 pounds. |

It will thus be seen that these samples of stamped tin stuff contained from 6 to 45 pounds of black tin per ton, which, owing to its physical condition, would be very unsuitable for concentration by jiggers.

The results obtained in these experiments are, to a certain extent, confirmed by the assay of some samples that were taken from Wheal Jane jiggers when that mine was in operation. Two samples of the classified sands entering the jiggers assayed at the rate of 22 and 25 pounds of black tin per ton of stuff, the hutch work at the rate of 2 cwts. black tin per ton, while the tailings leaving the jiggers, and which passed to waste, gave a produce of 7 pounds black tin per ton. Now, with Rittinger side blow percussion tables these particles of black tin associated with gangue would be given off as a middle product between the ore fit to be sent to the calciner and the waste, and could be discharged directly into a pulverizer, to be reduced for further treatment. Jiggers could no doubt be applied with advantage for the treatment of stuff where the grain of the black tin is coarse, such, for instance, as that produced by Mulberry & Drakewall's mines; but for the bulk of the ore yielded by the principal tin lodes it is not thought that they are likely to prove satisfactory machines.

In all departments of dressing, the object aimed at should be to attain the highest possible degree of efficiency consistent with the employment of the least possible amount of manual labor; not only on account of the greater cheapness of the work performed by self-acting machines, but also because, when the back of the master is turned, the quality of the work remains the same. With respect to the stream works, the 284,703 statute tons of sands and slimes discharged during 1884 into the Red river have been shown to have contained 1,344 tons of stream tin ore, representing a money value of £40,781, of which £35,016, or 85.9 per cent., was saved by the streamers. In other words, from stuff containing 10½ pounds of black tin per ton, the streamers caught 9 pounds per ton, allowing only 1½ pounds per ton to go to waste. Truly, an excellent result, speaking volumes in favor of the efficiency of the Cornish frame. It is improbable that the sands discharged into the sea will ever be made poorer than they are at present; but whether the stream works, considered financially, are equally successful, is another question. Taking into consideration the rates and dues that have to be paid, the large plant that has to be maintained, and the fact that during 1884 nearly nine hundred persons were employed on the Red river, it will readily be seen that, with the exception of the works immediately below the mines, not much more than a living can be made by the streamers with the present price of tin, and that they will have a very hard time of it indeed, should the mines eventually succeed in saving an increased percentage of the contents in black tin of the ore raised. Any improvement, however, in the efficiency of our dressing operations, or any lessening of their cost, would turn the scales between profit and loss at many of our mines, and, since a greater demand for labor would

thus be created than exists at present, would prove of immense benefit to the country at large.

*Prices.*—Although the price of tin is subject to greater fluctuations than other metals on account of the operations of speculators, the year 1885 was marked by a comparatively steady rise in the value of the metal, from 17⅛ cents per pound in New York at the beginning of the year, to 20¾ cents at the close. In July the price rose for a short time to 22⅛ cents.

The following table gives the range in price for each month in the year:

*Opening, highest, lowest, and closing prices of Straits tin at New York, in each month of the last three years.*

| Months. | 1885. | | | | 1884. | | | | 1883. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Opening. | Highest. | Lowest. | Closing. | Opening. | Highest. | Lowest. | Closing. | Opening. | Highest. | Lowest. | Closing. |
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 16¼ | 17¼ | 16.10 | 17⅛ | 19 | 19¼ | 17.90 | 18½ | 21⅛ | 21½ | 21 | 21 |
| February | 17⅜ | 17⅝ | 17¼ | 17⅝ | 18⅜ | 18⅜ | 17¾ | 17⅝ | 20⅝ | 21 | 20¾ | 20¾ |
| March | 17⅝ | 17.80 | 16.95 | 17.70 | 17¼ | 18⅜ | 17⅜ | 18½ | 20¼ | 22 | 20⅝ | 21⅝ |
| April | 17⅝ | 18¼ | 17⅝ | 18.20 | 18½ | 19¼ | 18½ | 19¼ | 21⅝ | 21⅝ | 21 | 21¼ |
| May | 18 | 19¼ | 18 | 19¼ | 19⅜ | 19⅜ | 18⅝ | 18¾ | 21¼ | 21⅞ | 21 | 21⅛ |
| June | 19¼ | 21⅛ | 19¼ | 21⅜ | 18¾ | 19¾ | 18.55 | 18¾ | 21⅛ | 21¼ | 20¾ | 21¼ |
| July | 21¼ | 23⅜ | 21¼ | 22 | 18¾ | 18⅞ | 18.70 | 18¾ | 21⅜ | 21⅜ | 21⅛ | 21½ |
| August | 22 | 22 | 20⅛ | 20⅞ | 18¼ | 19⅜ | 18.15 | 18.15 | 21⅜ | 21⅜ | 21 | 21 |
| September | 20⅞ | 21⅛ | 20⅜ | 20.80 | 18⅛ | 18.20 | 18.95 | 18 | 21 | 21⅛ | 21 | 21⅛ |
| October | 20.70 | 20.70 | 20¼ | 20⅓ | 17⅜ | 17⅜ | 16¼ | 16⅝ | 21⅛ | 21¼ | 20⅛ | 20¼ |
| November | 20⅓ | 21¼ | 20.05 | 21⅛ | 16⅝ | 16⅞ | 16⅛ | 16½ | 20¼ | 20⅜ | 19 | 19 |
| December | 21⅛ | 21⅛ | 20.55 | 20.80 | 16½ | 16½ | 16.10 | 16⅜ | 19 | 19 | 18½ | 19 |

*Average prices realized at the Banca and Billiton sales in the last three years.*

[Taken from the annual number of the *American Metal Market.*]

| Months. | Banca. | | | Billiton. | | |
|---|---|---|---|---|---|---|
| | 1885. | 1884. | 1883. | 1885. | 1884. | 1883. |
| | *Florins.* | *Florins.* | *Florins.* | *Florins.* | *Florins.* | *Florins.* |
| January | 48½ | 51⅜ | 56⅝ | | | |
| February | | | | 54.30 | 55.34 | 64½ |
| March | 48¼ | 52⅜ | 58¼ | | | |
| April | | | | 54½ | 58½ | 66⅝ |
| May | 52½ | 53⅛ | 58 | | | |
| June | | | | 60¼ | 56.22 | 64.43 |
| July | 55½ | 51½ | 57½ | | | |
| August | | | | 60.30 | 55¾ | 63.79 |
| September | 55½ | 49¾ | 57⅜ | | | |
| October | | | | 61⅜ | 49¾ | 63¾ |
| November | 56¾ | 46½ | 53½ | | | |
| December | | | | 63¾ | 50.13 | 56¾ |

*Imports and exports.*—The imports of pure tin in various forms decreased from 26,031,992 pounds in the fiscal year ending June 30, 1884, to 23,947,523 pounds in 1885; there was also a decrease in the importation of tin plates, sheets, etc., from 527,881,321 pounds in 1884 to 505,559,076 pounds in 1885, making a decrease in the total value of tin

imports amounting to $3,486,704. The record of imports and exports for a number of years is given below:

*Tin imported and entered for consumption in the United States,* 1867 *to* 1885, *inclusive.*

| Fiscal years ending June 30— | In blocks, bars or pigs, and grain tin. | | In plates, sheets, etc. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Cwts.* | | *Cwts.* | | |
| 1867 | ..... | $1,210,354.02 | ..... | $6,276,136.78 | $7,486,490.80 |
| 1868 | ..... | 1,454,327.36 | ..... | 6,893,072.07 | 8,347,399.43 |
| 1869 | 80,811 | 1,709,385.00 | 1,534,324 | 8,565,432.56 | 10,274,817.56 |
| 1870 | 81,702 | 2,042,887.71 | 1,333,150 | 7,628,871.51 | 9,671,759.22 |
| 1871 | 106,595 | 2,938,409.82 | 1,556,023 | 9,490,778.64 | 12,429,188.46 |
| 1872 | 102,006 | 3,033,837.45 | 1,617,627 | 10,736,906.59 | 13,770,744.04 |
| 1873 | 130,469 | 3,938,032.25 | 1,854,956 | 15,906,446.82 | 19,844,479.07 |
| 1874 | 116,442 | 3,199,807.07 | 1,553,860 | 13,322,976.14 | 16,522,783.21 |
| 1875 | 102,904 | 2,329,487.96 | 1,540,600 | 12,557,630.75 | 14,887,118.71 |
| 1876 | 93,176 | 1,816,506.00 | 1,767,210 | 10,226,802.87 | 12,043,308.87 |
| 1877 | 98,209 | 1,783,763.00 | 1,984,893 | 9,818,069.69 | 11,601,834.69 |
| 1878 | 128,849 | 2,167,350.00 | 2,166,489 | 9,893,639.61 | 12,060,989.61 |
| 1879 | 142,927 | 2,301,944.00 | 2,487,007 | 10,248,720.34 | 12,550,664.34 |
| 1880 | 290,007 | 6,153,005.68 | 3,298,534 | 16,524,590.19 | 22,677,595.87 |
| 1881 | 171,146 | 3,971,756.67 | 3,366,720 | 14,641,057.87 | 18,612,814.54 |
| 1882 | 197,544 | 5,204,251.68 | 3,926,311 | 16,550,834.64 | 21,755,086.32 |
| 1883 | 237,348 | 6,106,250.37 | 4,051,108 | 16,688,276.67 | 22,794,527.04 |
| 1884 | (*a*)26,031,992 | 5,429,184.01 | (*a*)527,881,321 | 18,931,072.70 | 24,360,256.71 |
| 1885 | 23,947,523 | 4,263,447.00 | 505,559,076 | 16,610,105.00 | 20,873,552.00 |

*a* Pounds in 1884 and 1885.

*Value of tin manufactures exported from the United States.*(*a*)

| Fiscal years ending September 30, until 1843, and June 30 since. | Value. | Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|---|---|
| 1826 | $4,515 | 1846 | $8,902 | 1866 | $79,461 |
| 1827 | 2,967 | 1847 | 6,363 | 1867 | 40,642 |
| 1828 | 5,049 | 1848 | 12,353 | 1868 | 27,110 |
| 1829 | 1,757 | 1849 | 13,143 | 1869 | 18,994 |
| 1830 | 4,497 | 1850 | 13,590 | 1870 | 46,007 |
| 1831 | 3,909 | 1851 | 27,823 | 1871 | 70,366 |
| 1832 | 3,157 | 1852 | 23,420 | 1872 | 67,241 |
| 1833 | 2,928 | 1853 | 22,988 | 1873 | 69,865 |
| 1834 | 2,230 | 1854 | 30,698 | 1874 | 62,973 |
| 1835 | 2,545 | 1855 | 14,279 | 1875 | 48,194 |
| 1836 | 5,604 | 1856 | 13,610 | 1876 | 48,144 |
| 1837 | 10,892 | 1857 | 5,622 | 1877 | 87,057 |
| 1838 | 10,179 | 1858 | 24,186 | 1878 | 116,274 |
| 1839 | 19,981 | 1859 | 39,289 | 1879 | 103,467 |
| 1840 | 7,501 | 1860 | 39,064 | 1880 | 144,185 |
| 1841 | 3,751 | 1861 | 30,229 | 1881 | 498,524 |
| 1842 | 5,682 | 1862 | 62,286 | 1882 | 198,608 |
| 1843 (nine months) | 5,026 | 1863 | 41,558 | 1883 | 191,947 |
| 1844 | 6,421 | 1864 | 46,968 | 1884 | 166,819 |
| 1845 | 10,114 | 1865 | 106,244 | 1885 | 162,304 |

*a* Classed as "tin, and manufactures of," from 1851.

*Oxide of tin imported and entered for consumption in the United States,* 1869 *to* 1883, *inclusive.*(*b*)

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1869 | $1,524 | 1877 | $1,886 |
| 1870 | 2,958 | 1878 | 929 |
| 1871 | 3,061 | 1879 | 2,138 |
| 1872 | 18,414 | 1880 | 2,849 |
| 1873 | 1,475 | 1881 | 2,510 |
| 1874 | 4,962 | 1882 | 920 |
| 1875 | 14,838 | 1883 | 4 |
| 1876 | 3,484 | | |

*b* Not enumerated in 1884 and 1885.

# ARSENIC.

The steadily declining price of arsenic during 1885 prevented any attempt at utilizing the well-known sources in this country, which have been given in previous reports. The use of arsenic for the extermination of grasshoppers in California and elsewhere in the West assumed large proportions, and the local demand might be profitably filled by saving the arsenic which passes off in roasting many silver and lead ores.

The nearest source of the present supply of arsenic is from the Del Oro mine, in Hastings county, Ontario. As this mine is operated by an American company, its product is nearly all sold in New York. The mine furnished about 400 tons of "crude" arsenic (90 to 95 per cent. arsenious oxide) and 40 tons of refined, practically pure, arsenious oxide, although it was only in operation from September 15 to the end of the year.

The price of arsenic fell from 2½ to 2⅛ cents during 1885.

*Imports.*—The importations, including Canadian arsenic, are given below, from which it is seen that, notwithstanding the above reduction in price, there was no increase in the total consumption.

*Arsenic imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Pounds.* | | | *Pounds.* | |
| 1867 | ..... | $17,700 | 1877 | 2,588,948 | $71,738 |
| 1868 | 1,442,142 | 19,191 | 1878 | 2,471,861 | 56,662 |
| 1869 | 1,442,576 | 29,450 | 1879 | 2,445,852 | 52,715 |
| 1870 | 566,500 | 12,643 | 1880 | 2,717,777 | 62,207 |
| 1871 | 1,329,693 | 29,822 | 1881 | 2,225,425 | 54,056 |
| 1872 | 1,109,811 | 30,337 | 1882 | 3,396,334 | 89,111 |
| 1873 | 612,116 | 16,373 | 1883 | 5,207,553 | 121,891 |
| 1874 | 1,636,335 | 39,985 | 1884 | 3,693,325 | 86,316 |
| 1875 | 2,327,742 | 49,430 | 1885 | 3,268,549 | 85,782 |
| 1876 | 447,019 | 13,784 | | | |

# ANTIMONY.

Although the sulphide of antimony has been found in a number of places, particularly in California, and notably at the Stayton mine, San Benito county, it seems, according to Mr. DeGroot, to occur in large quantity only at the San Emigdio mine, Kern county. This deposit and the manner of working it having been fully described in former volumes of these reports, only the operations carried on there during the past year need be mentioned. An attempt was made early in 1885 to concentrate the ore, but this proving unsatisfactory the plan of "cruding" it was afterwards adopted, and has since been continued with good results. By this plan the silica and other gangue matter is removed, leaving it so reduced in bulk that its transportation to the refinery at San Francisco costs comparatively little. The San Emigdio mine has lately become the property of the Anglo-American Association, which will hereafter work it, treating the ore by the above method. This company shipped several carloads of metallic antimony to New York during 1885, and expects to increase the shipments largely during 1886. The Company is actively prospecting elsewhere, and is buying all the 50 per cent. ore which is offered at $40 per ton. During the year there was talk of resuming work at the Stayton mine, which has long been idle, but nothing further has yet been done. Mr. H. S. Back reports the discovery of a new deposit of sulphide of antimony and bismuth, containing 53 per cent. of the former. The mine is in Shoshone county, Idaho, about 3 miles from the junction of the South fork of the Cœur d'Alene river.

*Imports.*—With the exception of a small quantity smelted in San Francisco, the antimony used in the United States has been imported in the following quantities:

*Antimony, and antimony ore, imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Crude and regulus. | | Ore. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | |
| 1867 | ..... | $63,919 | ..... | ..... | $63,919 |
| 1868 | 1,033,336 | 83,822 | ..... | ..... | 83,822 |
| 1869 | 1,345,921 | 129,918 | ..... | ..... | 129,918 |
| 1870 | 1,227,429 | 164,179 | ..... | ..... | 164,179 |
| 1871 | 1,015,039 | 148,264 | ..... | $2,324 | 150,588 |
| 1872 | 1,933,306 | 237,536 | ..... | 3,031 | 230,567 |
| 1873 | 1,166,321 | 184,498 | ..... | 2,941 | 187,439 |
| 1874 | 1,253,814 | 148,409 | ..... | 203 | 148,612 |
| 1875 | 1,238,223 | 131,360 | 6,460 | 609 | 131,969 |
| 1876 | 946,809 | 119,441 | 8,321 | 700 | 120,141 |
| 1877 | 1,115,124 | 135,317 | 20,001 | 2,314 | 137,631 |
| 1878 | 1,256,624 | 130,950 | 20,351 | 1,259 | 132,209 |
| 1879 | 1,380,212 | 143,099 | 34,542 | 2,341 | 145,440 |
| 1880 | 2,019,389 | 265,773 | 25,150 | 2,349 | 268,122 |
| 1881 | 1,808,945 | 253,954 | 841,730 | 18,199 | 272,153 |
| 1882 | 2,555,838 | 294,234 | 1,114,699 | 18,019 | 312,253 |
| 1883 | 3,064,050 | 286,892 | 697,244 | 11,254 | 298,146 |
| 1884 | *a*1,779,337 | 150,435 | 231,360 | 6,489 | 156,924 |
| 1885 | 2,668,302 | 223,741 | 243,635 | 8,783 | 232,524 |

*a* Classed as regulus only.

*Prices.*—The prices of antimony ruled lower in 1885 than in 1884, falling as low as 8½ cents per pound towards the end of the year. The fluctuations in price during the year are shown in the following table:

*Opening, closing, highest, and lowest prices of antimony of Cookson's brand and Hallett's brand in each month of the year* 1885 (*a*) *compared with the same month in the years* 1884 *and* 1883 (*b*).

[Cents per pound.]

| Months. | Cookson's. | | | Hallett's. | | |
|---|---|---|---|---|---|---|
| | 1885. | 1884. | 1883. | 1885. | 1884. | 1883. |
| January: | | | | | | |
| Opening | 10⅜ | 11½ | 11½ | 10⅛ | 10¼ | 10½ |
| Highest | 10⅜ | 12 | 11¼ | 10⅛ | 11 | 10⅜ |
| Lowest | 10.40 | 11.15 | 11 | 9⅞ | 10.20 | 10 |
| Closing | 10.45 | 11¾ | 11 | 9⅞ | 11 | 10⅜ |
| February: | | | | | | |
| Opening | 10.45 | 11⅜ | 11 | 9⅞ | 11 | 10⅛ |
| Highest | 10.45 | 11⅞ | 11 | 9⅞ | 11⅜ | 10⅛ |
| Lowest | 10⅜ | 11⅛ | 10⅞ | 9⅞ | 11 | 9⅞ |
| Closing | 10⅜ | 11¾ | 10⅞ | 9⅞ | 11¼ | 9⅞ |
| March: | | | | | | |
| Opening | 10¼ | 11¾ | 10¾ | 9¾ | 11¼ | 9⅞ |
| Highest | 10¼ | 11¾ | 10¾ | 9¾ | 11¼ | 9⅞ |
| Lowest | 10⅛ | 11⅜ | 10.70 | 9⅝ | 10⅜ | 9¾ |
| Closing | 10⅛ | 11⅜ | 10.70 | 9⅝ | 10⅞ | 9¾ |
| April: | | | | | | |
| Opening | 10.20 | 11¼ | 10⅝ | 9.70 | 10¾ | 9.70 |
| Highest | 10.20 | 11¼ | 10¾ | 9.70 | 10¾ | 9¾ |
| Lowest | 9¾ | 11 | 10⅜ | 9.45 | 10⅜ | 9.70 |
| Closing | 9¾ | 11 | 10.70 | 9.45 | 10⅜ | 9¾ |
| May: | | | | | | |
| Opening | 9¾ | 11 | 10.70 | 9.45 | 10⅝ | 9.70 |
| Highest | 9¾ | 11¼ | 10.70 | 9.45 | 10⅜ | 9.70 |
| Lowest | 9½ | 11 | 10⅝ | 9⅛ | 10½ | 9⅝ |
| Closing | 9½ | 11 | 10⅜ | 9⅛ | 10½ | 9⅝ |
| June: | | | | | | |
| Opening | 9½ | 11 | 10⅝ | 9⅛ | 10½ | 9⅝ |
| Highest | 9½ | 11 | 10⅜ | 9⅛ | 10½ | 9⅝ |
| Lowest | 9.35 | 10⅞ | 10½ | 8⅞ | 10.30 | 9½ |
| Closing | 9½ | 10⅞ | 10½ | 9 | 10.30 | 9½ |
| July: | | | | | | |
| Opening | 9½ | 10.85 | 10⅜ | 9 | 10.30 | 9⅛ |
| Highest | 9½ | 10.85 | 10⅜ | 9 | 10.30 | 9⅛ |
| Lowest | 9½ | 10⅜ | 10¼ | 8.90 | 10¼ | 9⅜ |
| Closing | 9½ | 10¾ | 10¼ | 8.90 | 10¼ | 9⅜ |
| August: | | | | | | |
| Opening | 9½ | 10¾ | 10¼ | 8⅞ | 10¼ | 9¼ |
| Highest | 9.55 | 10¾ | 10¼ | 8⅞ | 10½ | 9⅜ |
| Lowest | 9½ | 10½ | 10½ | 8¾ | 10⅜ | 9⅛ |
| Closing | 9½ | 10½ | 10¼ | 8¾ | 10⅜ | 9⅜ |
| September: | | | | | | |
| Opening | 9½ | 10½ | 10¼ | 8¾ | 10⅛ | 9⅜ |
| Highest | 9.65 | 10½ | 10¼ | 8¾ | 10⅜ | 9⅜ |
| Lowest | 9½ | 10⅜ | 10 | 8⅜ | 10 | 9 |
| Closing | 9½ | 10⅜ | 10½ | 8¾ | 10 | 9 |
| October: | | | | | | |
| Opening | 9½ | 10.35 | 10½ | 8⅜ | 9.95 | 9 |
| Highest | 9.55 | 10.35 | 10⅜ | 8¾ | 9.95 | 9 |
| Lowest | 9½ | 10¼ | 9⅞ | 8½ | 9⅞ | 8.85 |
| Closing | 9½ | 10¼ | 10 | 8½ | 9⅝ | 9 |
| November: | | | | | | |
| Opening | 9½ | 10⅜ | 10 | 8½ | 10½ | 9 |
| Highest | 9.55 | 10⅜ | 11 | 8½ | 10⅜ | 10¼ |
| Lowest | 9.45 | 10¼ | 10 | 8.45 | 9⅞ | 9 |
| Closing | 9.45 | 10⅜ | 10¾ | 8½ | 10⅜ | 10¼ |
| December: | | | | | | |
| Opening | 9.45 | 10½ | 11 | 8½ | 10½ | 10¼ |
| Highest | 9½ | 11 | 11¼ | 8⅝ | 10½ | 10¼ |
| Lowest | 9.45 | 10½ | 11 | 8½ | 10 | 10½ |
| Closing | 9.55 | 10¾ | 11¼ | 8½ | 10½ | 10¼ |

*a* From the *American Metal Market*, January 2, 1886.
*b* From the *American Metal Market*, January 3, 1885.

# BISMUTH.

It is stated by eastern consumers that one ton of bismuth was produced experimentally in the United States during 1885. This was probably made at Loveland, Colorado. According to the present indications bismuth may be produced on a commercial scale during the coming year; the increased activity in its development being due to the advance in price of the metal. This advance from $1.14 per pound, in 1884, to $1.87½ in 1885, was caused by a combination of the four principal producing districts, the Bolivian company, the Royal Saxon company, and the proprietors of the Australian mines. Even $2.25 was paid for the metal before the close of the year. Bismuth has lately been found in certain copper mattes from Montana, but none has been extracted from them.

*Imports.*—The imports of bismuth have remained practically without change during 1885, as shown in the following table. The use of the metal is limited.

*Bismuth imported and entered for consumption in the United States, 1868 to 1885, inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Pounds.* | | | *Pounds.* | |
| 1868 | | $30,149 | 1877 | | $12,279 |
| 1869 | | 29,047 | 1878 | | 45,838 |
| 1870 | | 30,695 | 1879 | | 47,523 |
| 1871 | | 47,047 | 1880 | | 82,711 |
| 1872 | | 40,554 | 1881 | | 83,209 |
| 1873 | | 17,025 | 1882 | 64,837 | 111,087 |
| 1874 | | 14,179 | 1883 | 54,702 | 89,683 |
| 1875 | | 8,723 | 1884 | 61,208 | 98,518 |
| 1876 | | 10,458 | 1885 | 61,024 | 84,425 |

# ALUMINUM.

By R. L. Packard.

The notice of the manufacture and sale of aluminum published in the "Mineral Resources of the United States, 1883 and 1884," contained an account of the method of manufacture employed in this country and the uses to which the metal was then applied. It was used for the lighter parts of mathematical and physical instruments of various kinds, suture wire, delicate weights, and as leaf for decorators. Its use was reported as increasing slowly, its cost precluding extensive employment. Its price ranged from 50 cents to $1 per ounce in 1884, and 1,800 ounces of the metal were produced during that year. It was also coming into use in the manufacture of alloys, and aluminum bronze was particularly mentioned, although no statistics were available to show the amount of that alloy produced in this country.

In 1885 the use of the metal was increased for light articles, and surgical instruments, medals, druggists' weights (on account of the large size of the light weights), thimbles, spoons, foil, fancy articles, fittings of traveling bags, soap and brush boxes, and racing plates or horse shoes, are mentioned as articles made of aluminum. Its price ranged from 50 to 95 cents per ounce, and dealers were of the opinion that its use would be greatly extended when its price was lowered, on account of its lightness, strength, and resistance to tarnish.

Colonel Frishmuth, of Philadelphia, whose process of extracting aluminum was described in the last report, states that he manufactured about 3,400 troy ounces in 1885, against 1,800 ounces the previous year.

The imports for the fiscal year 1885 were 439 pounds, valued at $4,736.

The estimated sales for 1885 were about 8,000 ounces. The use of aluminum in alloys, and particularly as aluminum bronze, received a new impulse in 1885, and the manufacture of that alloy, together with others containing aluminum, was then, apparently, raised to the level of an industry in this country by the Cowles Electric Smelting and Aluminum Company, of Cleveland, Ohio. The old way of making aluminum bronze and other alloys of aluminum did not differ essentially from the ordinary way of making alloys, and consisted in adding the aluminum to the melted copper. There are directions for doing this, one of which is to push the requisite amount of aluminum down through the melted copper in the crucible and hold it submerged by means of a dry stick of

hard wood. The old method required, of course, that metallic aluminum had first to be obtained by the costly process in vogue before it could be alloyed with the melted copper. By the new process alumina (oxide of aluminum) in the form of granulated corundum, is mixed with charcoal and granulated copper and placed between the large electrodes of a powerful dynamo-electric machine in a suitable furnace or receptacle of fire brick lined with charcoal and properly covered, and the current is then passed. Under the intense heat thus produced the alumina is reduced, and the aluminum set free forms an alloy with the copper melted at the same time, which alloy is afterwards remelted and the proper amount of copper is added to it to make the bronze required, containing 10 per cent. of aluminum, or 5 per cent., as the case may be. This method follows the line of older experiments which date back more than thirty years, but which did not have the advantage of the modern dynamo-electric machines, and appears to be a successful advance on the experiments of Sir W. Siemens, begun in 1878. The amount of aluminum bronze manufactured by the Cowles company in 1885 is stated by them to have been between 4,000 and 5,000 pounds. The market price of the bronze in 1884 ranged from $1 to $1.75 per pound. In 1885 the new method of manufacture brought its price down to 40 cents, or 30 cents in quantities of a ton or more. Castings of aluminum bronze containing 10 per cent. aluminum have reached a tensile strength of 110,000 pounds to the square inch cross section. Aluminum bronze is used for car and steamboat fixtures, and for decorations, chandeliers, engine bearings, journals, etc., and its proposed uses and those of other alloys of aluminum fill a long list, from large ordnance to small fancy articles.

Among the other alloys of aluminum manufactured by the Cowles Company are iron and aluminum containing 1 part of aluminum to 10 or 11 parts iron, sold at 50 cents per pound in ingots free on board at Cleveland, Ohio; aluminum brass containing from ½ to 3½ per cent. aluminum, and "aluminum silver," consisting of aluminum bronze (containing 5 per cent. of aluminum) and nickel, which is used for cutlery. All these alloys of aluminum are said to possess the faculty of not tarnishing, and have great tensile strength.

The electric furnace of the Cowles Company produced aluminum in the form of a black powder finely mixed with carbon dust and as metallic scales fused together with carbon. The amount so produced amounted in 1885 to perhaps 200 pounds, but it does not appear that it was utilized. Experiments have shown that this aluminum can be easily recovered, and it will probably soon be in the market.

A new use for aluminum was described by Mr. Petter Östberg, of Stockholm, Sweden, at the Pittsburgh meeting of the American Institute of Mining Engineers in February, 1886, and the following account is taken from the transactions of the society. This discovery, briefly described, is that the melting point of wrought iron, which is about 4,000° F. can be greatly reduced by adding a very small quantity of

aluminum (in the form of an alloy of iron) to the charge of wrought iron in the crucible so that the metal can be poured and cast without difficulty, especially if certain other portions of his invention are used. He has a furnace of special construction heated by petroleum, with an arrangement for introducing the aluminum alloy into the metal without cooling the atmosphere surrounding the crucible. Mr. Östberg explains that in order to make a casting it is necessary to heat the metal to be cast a number of degrees above its melting point, otherwise it would cool below the latter during the transfer to the molds and could no tbe poured. While in this superheated state the metal absorbs oxygen and other gases which produce injurious effects. He claims to effect the superheating without raising the temperature; or in less paradoxical language, he lowers the melting point of wrought iron by adding to the metal in the crucible from 0.05 to 0.1 per cent. of aluminum, which reduces the melting point by from 300° to 500° F. The former melting temperature is therefore the present superheating temperature. This has its analogy, as Mr. Östberg explains, in the fact that alloys generally melt at a lower temperature than would be expected from the melting points of their ingredients.

The statistics of the American manufacture of aluminum since 1883 are as follows:

*Production and value of American aluminum,* 1883 *to* 1885, *inclusive.*

| Years. | Ounces. | Value. |
|---|---|---|
| 1883 | 1,000 | $750 |
| 1884 | 1,800 | 1,350 |
| 1885 | 3,400 | 2,550 |

*Aluminum imported and entered for consumption in the United States,* 1870 *to* 1884, *inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Pounds.* | | | *Pounds.* | |
| 1870 | | $98 | 1879 | 284.44 | $3,423 |
| 1871 | | 341 | 1880 | 340.75 | 4,042 |
| 1873 | 2 | 2 | 1881 | 517.10 | 6,071 |
| 1874 | 683 | 2,125 | 1882 | 566.50 | 6,459 |
| 1875 | 434 | 1,355 | 1883 | 426.25 | 5,079 |
| 1876 | 139 | 1,412 | 1884 | 595.00 | 8,416 |
| 1877 | 131 | 1,551 | 1885 | 439.00 | 4,736 |
| 1878 | 251 | 2,978 | | | |

The amount of aluminum bronze manufactured in 1885 is stated at from 4,000to 5,000 pounds, which, at 40 cents, would be worth $1,600 to $2,000. The information on which this article is based was obtained directly from the manufacturers and dealers, and from authentic articles in the transactions of the American Institute of Mining Engineers, and oft he Franklin Institute.

# ZIRCONIUM.

By David T. Day.

The proposed use of zirconium oxide in electric lighting has made considerable inquiry of late for the mineral zircon in quantity. Patents are pending also on other applications of this mineral. This inquiry has developed the fact that zircon occurs in Buncombe county, North Carolina, in quantity sufficient for mining; it is in rock which has disintegrated to a considerable depth, and hence can easily be collected. In fact, 1,000 pounds were gathered at one time and 800 pounds at another, besides many small quantities for cabinet collections, etc., aggregating over 2,000 pounds in all taken from one locality.

A great drawback to the use of zirconium oxide has been the great difficulty in obtaining the substance in pure condition. Several methods have been used, but usually with poor results, especially when the zircon contains iron. The method which has yielded the best results so far, consists in fusing the finely powdered zircon with acid sulphate of potassium, which decomposes the mineral, converting the zirconium into a basic sulphate which is insoluble. This is fused with caustic soda, leaving zirconium hydroxide capable of solution in strong sulphuric acid. From this, zirconium hydroxide is again precipitated by ammonia, and after much washing, it is ignited. The method yields only fair results, and is long and tedious. Lately E. Linnemann (*Monatshefte für Chemie*, vol. 6, 335, 447) has added greatly to the chance of utilizing zirconium by publishing a better method for preparing the oxide. Zircon crystals are first exposed to fumes of hydrofluoric acid; after this they can be easily pulverized in an iron mortar. In order to decompose the powdered zircon, 25 grams are melted with 100 grams of caustic soda, and 10 grams of pure sodium fluoride in a silver crucible. In ten to fifteen minutes the principal reaction is over, and the mass is kept melted for half an hour, and then while melted poured out, and after cooling washed out with hot water. Zirconium oxide is left together with the oxides of other metals. From these, zirconium chloride is separated by treatment with a mixture of fuming hydrochloric acid (sp. gr.=1.17), absolute alcohol, and ether, in which zirconium chloride, $ZrCl_4$, is almost insoluble while the other chlorides usually present are soluble. In order to purify the zirconium chloride completely it is recrystallized repeatedly from hot concentrated hydrochloric acid. It is then converted into zirconium oxide by ignition. The oxide thus ob-

tained is quite pure, and has been used already in producing a light under conditions where lime could not be used. The same author has just described an oxyhydrogen light of peculiar construction by which an unusually high temperature is produced. The author says: "This blast lamp can be used advantageously for a lime light, or, since lime *melts*, for producing the zirconium light." He uses for this purpose plates of zirconium oxide 4 millimeters thick and 15 millimeters broad, set in a piece of platinum. The plates are made by igniting zirconium chloride and then pressing the resulting oxide strongly and repeating this several times. The light is steady and white, gives a continuous spectrum, which embraces the Fraunhofer lines A to H, and, with illuminating gas at a pressure of 2½ inches of water and oxygen, at a pressure sixteen times as great, a light of 60, 120, or 200 candles, according as 1, 1½, or 2 cubic feet of illuminating gas, and ½, 1, or 2 cubic feet of oxygen are used. It is highly probable that a light of this kind will be used largely to replace the lime light, since the pieces of zirconia are practically indestructible.

# STRUCTURAL MATERIALS.

By H. S. Sproull.

From a few sections of the country reports indicate some falling off in the production of structural materials, but generally there has been a gain for standard descriptions, and occasionally of very decided character. The losses appear to be due to local influences alone, having no further bearing, while the increase may be accepted as a fair reflection from the entire country. The prime factor, leading to a fuller production, was the low ruling cost of material, which presented an attraction for consumption, and led to larger investments in real estate improvements, especially in the larger cities and their suburbs. Some increase in public works and improvements has opened the outlet still wider, and promises additional expansion. Notwithstanding the considerable increase in quantity of material produced in 1885, the value only exceeded that of 1884 in a few instances, and in some cases ran rather behind, as the result of the lower values brought about by various influences, as will be explained farther on. The profits of the manufacturing interest have naturally become somewhat curtailed, yet rarely to a serious extent, and there is very universal testimony to warrant the assertion that no attempt has been made to balance the shrinkage in price by lowering the grade of the product; but, on the contrary, every reasonable effort was put forth to enhance the quality and attractions as an additional stimulant to consumption.

The absence of complete and authentic records of production is strikingly noticeable in respect to all structural material proper. In a few cases the difficulty might be overcome by a systematic and unanimous action of manufacturers, but the scattered location and crude methods of the numerous small concerns engaged in the industry precludes the possibility of giving statistics of actual results, and estimates must therefore be depended upon. No estimates have been accepted, however, until consultation and comparison of views with responsible sources of information confirmed the amounts assumed; and the following reports may be considered quite as near positive records as it is possible to obtain with the means now available. Manufacturers and producers generally, however, are becoming impressed with the value of reliable figures, and through trade organizations or co-operation with the statistical departments of the States concerned in the production, it may become possible to secure a comprehensive record.

In the preparation of this report, statistics have been quoted from the United States Bureau of Statistics; the annual reports of industrial and statistical bureaus of most of the States referred to; from responsible trade journals published in various sections of the country, and from private records of the most reliable character. Information has also been obtained through the courtesy of Mr. Thomas B. Bancroft, chief inspector of mines for the State of Ohio; Messrs. James M. Swank and L. E. Schlauch, of Pennsylvania; Mr. J. B. Speed, of Kentucky; the Buffalo Cement Company; Messrs. George W. White and Jerome A. King, of New York City. The report for the Rocky mountain division has again been furnished by Mr. F. F. Chisolm, and that for California by Mr. C. G. Yale.

## BUILDING STONE.

*Present status.*—The value of the building stone quarried in the United States during the past four years is estimated as follows:

| Years. | Value. |
|---|---|
| 1882 | $21,000,000 |
| 1883 | 20,000,000 |
| 1884 | 19,000,000 |
| 1885 | 19,000,000 |

Preparatory to making the foregoing estimate for 1885, a wider expanse of territory was brought under investigation and a more thorough form of inquiry adopted than in 1884, with no better results in obtaining positive data. Indeed, the generally ambiguous and evasive replies to requests for actual figures forcibly indicated the absence of method among the majority of producers for compiling and preserving records of their output, and that in conjunction with almost insurmountable difficulties in the way of knowing and reaching all sources of supply, led to an early abandonment of the effort toward exact results by this means. Communication with numerous producers, distributors, and consumers, however, furnished valuable hints and suggestions from which an estimate corresponding with that for 1884 was fairly warranted, and $19,000,000 may be accepted as the nearest approximation to the value of the production for 1885, of which the available sources of information will admit. In adjusting the influences existing during 1885 it was found that on one side must be placed evidences of an increased output in many sections, and especially when tributary to some of the large cities of the interior; the opening up of new quarries; and the fact that a certain amount of surplus production was submitted to as a means for keeping desirable labor busy and contented. In opposition were to be found, several important localities showing a considerable decrease in consumption, and an almost universal admission of a lower value. While

the actual amount of stone quarried may have been larger than in 1884 its value was no greater, according to the best authorities.

Not even an estimate can be ventured upon regarding the proportion of the numerous varieties of stone used, and probably there was no important variation from the previous year, yet granite and some of the harder descriptions of sandstone increased slightly in favor and the brown stones have fallen somewhat further into disrepute. The latter has been most marked in connection with the coarser varieties of brown stone quarried near and used in some of the prominent seaboard cities, where the severity of the weather requires something that will show more positive and longer resistance to defacement and disintegration. An importation of Scotch stone of light color and good promise as to durability has found some favor in that connection, yet quite as desirable and probably a better quality could be obtained from our domestic quarries, especially those located on deposits of refractory sandstone and the highly siliceous limestones, etc., all calculated to develop an extreme degree of durability and maintain a uniform shade. Probably the most reliable returns obtained from the question of production were those given for bluestone. It, in common with the figures for all other stone, is an estimate only, yet the result may be accepted as approximating closely the amount actually quarried. About the entire supply is taken from deposits in the State of New York, with the city of Rochester on the western boundary line of the working field, the Hudson River on the east, and thence running down into the Lehigh and Wyoming sections of Pennsylvania, an area, in connection with a few smaller and unimportant sources of supply, producing in 1885 some 250,000 long tons with a quarry value reaching $2,000,000, quite a falling off from the product of the preceding year, as will be seen in the annexed table. The valuations are included in the general estimate of the production of building stone.

*Quantity and value of bluestone quarried in the United States in* 1884 *and* 1885.

| Years. | Quantity. | Value. |
|---|---|---|
| | *Long tons.* | |
| 1884 | 300, 000 | $2, 500, 000 |
| 1885 | 250, 000 | 2, 000, 000 |

*New sources of supply.*—Information concerning new sources of supply is not abundant, but the condition of trade in building stone was hardly calculated to stimulate unusual effort toward development. In Virginia the quarrymen have opened up a few new beds of granite contiguous to old working ground and showing no really new qualities. Between Richmond and Lynchburg the available supplies are becoming greater, and during 1885 a very fine quarry of brownstone was opened at Midway Mills. New Hampshire and Connecticut have added some-

what to their productive capacity. The production in Pennsylvania is increasing slightly, and just at the close of the year another granite quarry was opened near French Creek Falls, Chester county. At Rockfield, Kentucky, an oölitic limestone has been further developed, showing stone of exceptionally good quality, comparing favorably with the Portland oölitic stone of England. An extensive plant has been erected and the necessary rail connections made in order to place the stone upon the market. Considerable prospecting has taken place in the western and southern States, and some valuable quarries of building stone located. In Utah attention is turning toward the fine deposits of white and black marble and brownstone, but no active measures have as yet been taken to utilize the supply, partly owing to absence of proper transportation facilities. An excellent building stone is reported in the southeastern part of Minnesota, of bright-red color, and is called "Minnesota redstone," but no detailed description has been forwarded.

*Rocky mountain division.*—A bed of remarkably fine marble was opened during 1885 on one of the branches of Rock creek, Gunnison county, Colorado. The marble was made the subject of a special examination by the Union Pacific Railway Company, and all tests of its quality proved in the highest degree satisfactory. There is an abundance of the marble, but it is so difficult of access that it was found impracticable to attempt the development of the district. Marble of fair quality is found on the Upper Arkansas, near Grand Junction, and at other western points, but is nowhere mined or worked.

### SLATE.

*Production.*—Slate deposits are known to exist from Maine to Michigan and from the Saint Lawrence to the Gulf States, but actual development is confined to comparatively few localities. Maine, Vermont, and New York produce moderate quantities, and small beds of very good slate are worked in Michigan and Virginia, but the great bulk of the total product of the United States comes from the immense quarries situated in Lehigh and Northampton counties, Pennsylvania. In the latter section over three thousand men were employed in 1885, mostly of Welsh and English nativity, and the result of their labor was a liberal increase in the product. The bulk of the manufacture is in the form of roofing slate, which is distributed over the entire country, and a fair proportion finds a foreign outlet. Various sizes are made, to meet architectural designs and other requirements of the trade. They are sold in "squares." A "square" is 100 square feet, weighs 600 pounds, and covers the same area as 1,000 shingles. The cost, delivered from the quarry, ready for shipment, in 1885, was $2.50 to $3.75 per square, against $3.50 to $4 per square in 1884. The scale of wages paid at quarries, in 1885, was as follows: Splitters, 18 to 20 cents per hour; blockmakers, 15 to 18 cents per hour; laborers, 10 to 13 cents per hour.

*Production of roofing slate in all sections during the years* 1884 *and* 1885.

[Squares of 100 square feet each.]

| Sections. | 1884. | 1885. |
|---|---|---|
| Bangor and Pen Argyl region, Pennsylvania | 195,505 | 196,832 |
| Slatington section, Pennsylvania | 104,000 | 108,000 |
| Vermont | 85,000 | 130,000 |
| Maine | 41,000 | 34,000 |
| Chapman's | 29,499 | 26,328 |
| Peach Bottom | 10,000 | 14,500 |
| Virginia | 9,000 | 17,300 |
| Michigan | 7,000 | 10,000 |
| Total | 481,004 | 536,960 |

*Total yearly production of roofing slate from* 1879 *to* 1885, *inclusive.*

| Years. | Number of squares. | Average price per square, delivered on cars. | Value. |
|---|---|---|---|
| 1879 | 367,857 | ..... | ..... |
| 1880 | 382,867 | ..... | ..... |
| 1881 | 454,070 | ..... | ..... |
| 1882 | 501,000 | ..... | ..... |
| 1883 | 506,200 | ..... | ..... |
| 1884 | 481,004 | $3.85 | $1,851,865 |
| 1885 | 536,960 | 3.07 | 1,648,467 |

Towards the close of the year a fine bed of slate was discovered on Fremont island, Great Salt Lake, Utah, and after a careful examination of the quarry by experts a company was formed to develop and work it. The production will find a western market at a great saving in transportation charges, and no doubt will stimulate consumption.

*Condition of the slate industry.*—The slate quarrying industry of the country during the years 1884 and 1885 was, through various influences, suffering considerable depression and afforded little profit to the producer. A steady shrinkage in consumption, very active competition to secure such opportunities for the disposal of supplies as could be found, and scarcely any modification in the cost of production, were, in brief, the dominant factors under which the trade labored. There was nothing to indicate that roofing slate had lost favor, except in some of the cities, but accumulations of stock carried over from former seasons and a diminution in the erection of buildings upon which a covering of slate appeared to be an absolute necessity, placed the quarrymen at a decided disadvantage when attempting to dispose of the new output. One of the greatest checks to the demand was caused by general retrenchment in the matter of railway construction, improvement and repairs, since depots, freight sheds, engine stables, etc., during active periods of increase in railroad property, form a most liberal outlet for roofing slate. A curtailment of production was difficult to accomplish, except at the risk of still more disastrous results to the producer.

The labor employed in the quarries must be peculiarly skilled, and cannot readily be replaced, a fact that induced the policy of keeping the men at work, and forcing a sale of the product rather than of shutting down entirely, and this was carried out with no fairly compensating modification in the rate of wages. Thus, without securing much advantage on the cost of production, and being compelled to follow a small decline in the selling price during 1884, the margin of profit to the producer has been exceedingly small. Tile for roofing purposes has been used to some extent, but cannot be considered as a competitor with slate, owing to the non-absorbent qualities of the latter, and general ability to withstand the elements.

*Exports.*—For many years roofing slate has contributed a fair proportion to the export movement of the United States. During 1876, 1877, 1878, and partially again during 1880, Great Britain and the continent became very liberal customers, not the least remarkable feature of the trade being shown in the shipment of several cargoes direct to Welsh ports, thus practically selling at the very door of England's great base of supplies. Since 1881, however, the European demand has about all disappeared and left shippers dependent upon the custom of South America, the West Indies and Australia, the former two countries requiring small amounts, but the latter affording quite a marked outlet. Indeed, the latter trade increased very rapidly during 1885 as a result of the uncommonly low prices ruling, a large proportion of the stock having been sold and delivered on the pier alongside of vessels at $4 per square, and in some instances at 25 cents per square lower; a basis upon which it was found possible to compete with England in her own colonial market, and also to furnish a vent for the enforced surplus production of this country, to which reference has before been made. No general record of the export movement is obtainable, but probably 90 per cent. is shipped from the port of New York, and as the figures for that point were perfected under careful compilation they afford an excellent index to the foreign movement in roofing slate for a series of years.

*Exports of roofing slate from the port of New York from* 1876 *to* 1885, *inclusive.*

| Years. | Tons. | Pieces. | Value. |
|---|---|---|---|
| 1876 | 19,475 | 646,985 | $377,233 |
| 1877 | 25,565 | 2,895,428 | 646,272 |
| 1878 | 12,320 | 1,834,225 | 308,852 |
| 1879 | 4,792 | 3,085,124 | 166,220 |
| 1880 | 11,267 | 1,698,522 | 220,292 |
| 1881 | 2,927 | 3,522,527 | 138,904 |
| 1882 | 864 | 4,337,801 | 153,318 |
| 1883 | 187 | 1,488,226 | 54,063 |
| 1884 | 50 | 2,776,236 | 90,262 |
| 1885 | ..... | 4,113,204 | 115,206 |

Slate is not confined to its use as a roofing material by any means, but, on the contrary, is probably more universally used than any other

stone. In composition and texture it is admirably adapted to the reception of carved and molded designs, is susceptible of a high polish, and possesses great power of resistance to the principal destructive elements, besides having the additional merit of wide range of color, embracing black, dark blue, purple, purple-clouded green, gray-clouded green, light green, and a clear, bright red. The scope of consumption is rapidly expanding, and among the uses to which slate is applied the following may be enumerated: Flagging, flooring, floor tiles, molding for tiles, vestibule trimmings, slabs, etc., wainscoting, mantels, hearthstones, steps, risers, platforms, sills and lintels, turned balusters, laundry and bath tubs, sinks and wash trays, meat and water tanks, refrigerator and cooling-room shelves, cistern linings, brewers' vats, mangers, butchers' and curriers' tables, bar fixtures, billiard table beds, urinals, school slates and blackboards, countertops, vault work, grave linings and covers, and memorial tablets. Of the above no record of production or value can be obtained that would prove at all useful as a basis for estimates. Possibly a faint idea of the proportions devoted to these various uses might be obtained from the production of the Slatington section, where, besides an output of 108,000 squares of roofing slate, there were also made, in round numbers, 39,900 cases of school slates; 31,850 pieces, or 1,430 cases, or 27 carloads of flagging; 5,900 cases blackboards; 30 cases mantels and hearths, and 47 carloads of sawed and shaved slate. The export of manufactured slate has also proved a significant item for several years past, but it is generally understood that the stock handled on foreign orders was composed almost wholly of school slates, with possibly an occasional parcel of mantels and hearths. It is again necessary to rely upon the figures of the port of New York as an indication of the extent and progress of the business with foreign countries, but the annexed tables represent a very large proportion of the entire shipment of the United States.

*Exports of manufactured slate from the port of New York, 1876 to 1885, inclusive.*

| Years. | Cases. | Value. | Years. | Cases. | Value. |
|---|---|---|---|---|---|
| 1876 | 10,612 | $87,500 | 1881 | 14,414 | $62,109 |
| 1877 | 8,675 | 68,437 | 1882 | 14,625 | 68,150 |
| 1878 | 13,274 | 88,215 | 1883 | 8,943 | 40,674 |
| 1879 | 17,505 | 74,251 | 1884 | 12,189 | 53,021 |
| 1880 | 15,674 | 76,709 | 1885 | 10,573 | 49,965 |

*Exports of all kinds of slate from the port of New York, 1876 to 1885, inclusive.*

| Years. | Value. | Years. | Value. |
|---|---|---|---|
| 1876 | $464,733 | 1881 | $201,013 |
| 1877 | 714,709 | 1882 | 221,468 |
| 1878 | 397,067 | 1883 | 94,737 |
| 1879 | 240,471 | 1884 | 143,283 |
| 1880 | 297,001 | 1885 | 165,171 |

*Imports and exports of building stone.*—The following tables show the extent of the for foreign commerce of the United States in marble and other stone:

*Marble imported and entered for consumption in the United States, 1867 to 1883, inclusive.*

| Fiscal years ending June 30— | Sawed, dressed, etc., not over 2 inches in thickness. | Sawed, dressed, etc., over 2 and not over 3 inches in thickness. | Sawed, dressed, etc., over 3 and not over 4 inches in thickness. | Sawed, dressed, etc., over 4 and not over 5 inches in thickness. | Sawed, dressed, etc., over 5 and not over 6 inches in thickness. | Veined and all other in blocks, etc. | White, statuary, Brocatella, etc. | Not otherwise specified. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 1867 | ..... | ..... | ..... | ..... | ..... | $192,514 | $2,540 | $51,978 | $247,033 |
| 1868 | ..... | ..... | ..... | ..... | ..... | 309,750 | 4,403 | 85,783 | 399,936 |
| 1869 | ..... | ..... | ..... | ..... | ..... | 359,881 | 3,898 | 101,309 | 465,088 |
| 1870 | ..... | ..... | ..... | ..... | ..... | 332,839 | 3,713 | 142,785 | 479,337 |
| 1871 | $5,973 | $168 | $77 | $44 | $28 | 400,158 | 1,134 | 118,016 | 525,598 |
| 1872 | 3,499 | 1,081 | 452 | ..... | 318 | 475,718 | 4,017 | 54,539 | 539,624 |
| 1873 | 3,124 | 21 | ..... | ..... | ..... | 396,671 | 4,148 | 69,991 | 473,955 |
| 1874 | 1,837 | ..... | ..... | ..... | ..... | 474,680 | 2,863 | 51,699 | 531,079 |
| 1875 | 1,456 | 427 | 96 | ..... | ..... | 527,628 | 1,623 | 72,389 | 603,619 |
| 1876 | 595 | 126 | 204 | 87 | ..... | 529,126 | 1,151 | 60,596 | 591,885 |
| 1877 | 2,124 | ..... | ..... | ..... | ..... | 349,590 | 1,404 | 77,293 | 430,411 |
| 1878 | 198 | 11 | 8 | ..... | ..... | 376,936 | 592 | 43,915 | 421,660 |
| 1879 | 184 | ..... | ..... | ..... | ..... | 329,155 | 427 | 54,857 | 384,623 |
| 1880 | ..... | ..... | ..... | ..... | ..... | 531,908 | 7,239 | 62,715 | 601,862 |
| 1881 | 339 | ..... | ..... | ..... | ..... | 470,047 | 1,468 | 82,046 | 553,900 |
| 1882 | 655 | ..... | ..... | ..... | ..... | 486,331 | 3,582 | 84,577 | 575,145 |
| 1883 | 619 | ..... | ..... | ..... | ..... | 533,096 | 2,011 | 71,905 | 607,631 |

During the last two fiscal years the classification has been as follows:

| Classification. | 1884. | 1885. |
|---|---|---|
| Marble: | | |
| In blocks, rough or squared, of all kinds | $511,287 | $429,186 |
| Veined marble, sawed, dressed, or otherwise, including marble slabs and marble paving tiles | 12,941 | 43,923 |
| All manufactures of, not specially enumerated | 67,829 | 54,772 |
| Total | 592,057 | 527,881 |

*Building stone (exclusive of marble), paving stone, and stone ballast imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Building stone, dressed. | Building stone, rough. | | Sandstone. | Slate chimney pieces, mantles, etc. | Roofing slate. | Limestone. | Paving stones. | Ballast. | Total value. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity. | Value. | | | | | | | |
| | | *Long tons.* | | | | | | | | |
| 1867 | ..... | ..... | ..... | ..... | $37, 510 | $85, 204 | ..... | ..... | ..... | ..... |
| 1868 | $59, 081 | ..... | ..... | ..... | 16, 045 | 118, 776 | ..... | $5, 718 | ..... | ..... |
| 1869 | 61, 408 | ..... | $8, 237 | $1, 171 | 19, 602 | 85, 364 | ..... | 467 | $3, 987 | ..... |
| 1870 | 150, 619 | ..... | ..... | 3, 201 | 19, 879 | 107, 521 | ..... | 2, 034 | 10. 518 | ..... |
| 1871 | 145, 759 | 1, 455 | 16, 982 | 3, 660 | 21, 381 | 117, 484 | ..... | ..... | 34, 703 | ..... |
| 1872 | 162. 614 | 10, 723 | 39, 515 | 7, 680 | 25, 925 | 107, 192 | $2, 459 | 5, 529 | 11, 303 | $362, 217 |
| 1873 | 218, 236 | 20, 226 | 73, 889 | 6, 160 | 26, 643 | 91, 503 | 1, 486 | 3, 788 | 17, 143 | 438, 848 |
| 1874 | 238, 080 | 19. 658 | 81, 645 | 8, 534 | 27, 519 | 89, 519 | 1, 639 | 7. 246 | 21, 882 | 467. 664 |
| 1875 | 275, 633 | 15, 748 | 67, 357 | 10, 986 | 42, 022 | 16, 342 | 2, 023 | 2, 017 | 9, 025 | 425, 405 |
| 1876 | 316, 404 | 8, 199 | 31, 124 | 7, 174 | 44, 266 | 2, 051 | 1, 938 | 1, 005 | 9, 350 | 416, 312 |
| 1877 | 201, 034 | 7, 584 | 25, 571 | 5, 492 | 34, 479 | 4 | 1, 705 | 485 | 6, 272 | 275, 042 |
| 1878 | 153, 693 | 10, 197 | 37, 878 | 7, 136 | 39, 935 | 275 | 2, 614 | 1, 950 | 6, 989 | 250, 470 |
| 1879 | 125, 493 | 6, 845 | 24, 531 | 13, 956 | 46, 260 | 620 | 1, 456 | 2, 943 | 2, 365 | 217, 624 |
| 1880 | 75, 501 | 11, 035 | 43, 997 | 10, 220 | 51, 165 | 72 | 2, 560 | 2, 383 | 7. 572 | 193, 470 |
| 1881 | 76, 741 | 15, 867 | 65, 950 | 15, 115 | 46. 862 | 2 | 1, 990 | 3, 799 | 5, 401 | 215, 860 |
| 1882 | 104, 296 | 16, 778 | 75, 369 | ..... | 45, 774 | 154 | 2, 710 | 16, 599 | 8. 792 | 253, 694 |
| 1883 | 127, 476 | 14, 324 | 64, 767 | ..... | 44, 375 | 2, 813 | 1, 841 | 2, 629 | 5, 745 | 249, 646 |
| 1884 | 122, 463 | 12, 198 | 50, 860 | ..... | 34, 640 | 16. 099 | 143 | 2, 576 | 2, 551 | 229, 332 |
| 1885 | 145, 344 | 13, 183 | 64, 680 | ..... | 56, 913 | 5, 196 | ..... | ..... | 4, 056 | 276, 189 |

*Marble and stone of domestic production exported from the United States.*

| Fiscal years ending September 30, until 1842, and June 30 since. | Rough. | Manufactured. | Total. | Fiscal years ending June 30— | Rough. | Manufactured. | Total. |
|---|---|---|---|---|---|---|---|
| 1826 | ..... | $13, 303 | $13, 303 | 1856 | ..... | $162, 376 | $162, 376 |
| 1827 | ..... | 3, 505 | 3, 505 | 1857 | ..... | 111, 403 | 111, 403 |
| 1828 | ..... | 3, 122 | 3, 122 | 1858 | ..... | 138, 590 | 138, 590 |
| 1829 | ..... | 2, 647 | 2, 647 | 1859 | ..... | 112, 214 | 112, 214 |
| 1830 | ..... | 4, 655 | 4, 655 | 1860 | ..... | 176, 239 | 176, 239 |
| 1831 | ..... | 3, 588 | 3, 588 | 1861 | ..... | 185, 267 | 185, 267 |
| 1832 | ..... | 3, 455 | 3, 455 | 1862 | ..... | 195, 442 | 195, 442 |
| 1833 | ..... | 5, 087 | 5, 087 | 1863 | ..... | 138, 428 | 138, 428 |
| 1834 | ..... | 7, 359 | 7, 359 | 1864 | $57, 715 | 144, 647 | 202, 362 |
| 1835 | ..... | 8, 687 | 8, 687 | 1865 | 74, 261 | 183, 782 | 258, 043 |
| 1836 | ..... | 4, 414 | 4, 414 | 1866 | 89, 703 | 112, 830 | 202, 533 |
| 1837 | ..... | 5, 374 | 5, 374 | 1867 | 53, 983 | 138, 558 | 192, 541 |
| 1838 | ..... | 5, 199 | 5, 199 | 1868 | 60, 399 | 105, 046 | 165, 445 |
| 1839 | ..... | 7, 661 | 7, 661 | 1869 | 62, 266 | 87, 135 | 149, 401 |
| 1840 | ..... | 35, 794 | 35, 794 | 1870 | 42, 227 | 138, 046 | 180, 273 |
| 1841 | ..... | 33, 546 | 33, 546 | 1871 | 135, 672 | 137, 613 | 273, 285 |
| 1842 | ..... | 18, 921 | 18, 921 | 1872 | 156, 976 | 165, 311 | 322, 287 |
| 1843 (nine months) | ..... | 8, 545 | 8, 545 | 1873 | 96, 735 | 189, 795 | 286, 530 |
| 1844 | ..... | 19, 135 | 19, 135 | 1874 | 126, 669 | 168, 977 | 295, 646 |
| 1845 | ..... | 17, 626 | 17, 626 | 1875 | 125, 968 | 254, 356 | 380, 324 |
| 1846 | ..... | 14, 234 | 14, 234 | 1876 | 95, 480 | 236, 255 | 331, 735 |
| 1847 | ..... | 11, 220 | 11, 220 | 1877 | 131, 716 | 917, 937 | 1, 049, 653 |
| 1848 | ..... | 22, 466 | 22, 466 | 1878 | 142, 661 | 597, 356 | 740, 017 |
| 1849 | ..... | 20, 282 | 20, 282 | 1879 | 143, 457 | 430, 848 | 574, 305 |
| 1850 | ..... | 34, 510 | 34, 510 | 1880 | 199, 051 | 453, 912 | 652, 963 |
| 1851 | ..... | 41, 449 | 41, 449 | 1881 | 220, 362 | 409, 433 | 629, 795 |
| 1852 | ..... | 57, 240 | 57, 240 | 1882 | 180, 774 | 433, 656 | 614, 430 |
| 1853 | ..... | 47, 628 | 47, 628 | 1883 | 152, 182 | 389, 371 | 541, 553 |
| 1854 | ..... | 88, 327 | 88, 327 | 1884 | 188, 245 | 415. 015 | 603, 260 |
| 1855 | ..... | 168, 546 | 168, 546 | 1885 | 182, 719 | (a)330, 786 | 513, 505 |

a Includes roofing slate.

*Marble and stone, and manufactures of marble and stone, of foreign production exported from the United States, 1872 to 1885, inclusive.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1872 | $1,929 | 1879 | $6,364 |
| 1873 | 4,571 | 1880 | 6,816 |
| 1874 | 1,928 | 1881 | 709 |
| 1875 | 3,428 | 1882 | 4,848 |
| 1876 | 13,371 | 1883 | 490 |
| 1877 | 8,475 | 1884 | 8,420 |
| 1878 | 3,448 | 1885 | 14,406 |

Summarizing the foregoing statistics, the movement during the fiscal years 1882, 1883, 1884, and 1885 may be stated thus:

*Balance of trade in marble and stone.*

| Fiscal years ending June 30— | Imports. | Exports. | | | Excess of imports over exports. |
|---|---|---|---|---|---|
| | | Of domestic production. | Re-exports of foreign production. | Total exports. | |
| 1882 | $828,839 | $614,430 | $4,848 | $619,278 | $209 561 |
| 1883 | 1,475,658 | 541,553 | 490 | 542,043 | 933,615 |
| 1884 | 821,389 | 603,260 | 8,420 | 611,680 | 209,709 |
| 1885 | 804,070 | 513,505 | 14,406 | 527,911 | 276,159 |

## BUILDING SAND.

Much has been written upon the proper theoretical proportions and qualities of building sand to be used in the preparation of mortar, etc. In actual mixing, however, the average consumer simply handles supplies according to his very practical ideas of cost and convenience, and quality is too frequently a secondary consideration. Cost as usual varies greatly, and while in the great cities 50 to 75 cents per ton might be named, those figures are far above the average, contractors in some localities even finding it necessary to pay for the privilege of disposing of the amount they excavate. Equally uncertain is the production; an approximation to the quantity of sand used simply as a constructive material may be reached by using the totals of other cohesive articles as a basis, and calculating the natural relative proportions used in the preparation of mortars as commonly made; deductions drawn from such suggestions indicate 52,116,000 long tons of sand worked up for building purposes during 1885. This estimate does not cover the supply used for paving and kindred purposes, nor the vast quantities of sand yearly removed from original beds and transferred to railway embankments, harbor and river improvements, etc. Of course supplies are inexhaustible, and outside of city limits can generally be found about where they are wanted.

*Imports and exports of sand and gravel.*

| Fiscal years ending June 30— | Imports. | Exports. | Fiscal years ending June 30— | Imports. | Exports. |
|---|---|---|---|---|---|
| 1864 | ..... | $5,109 | 1877 | ..... | $10,803 |
| 1865 | ..... | 9,438 | 1878 | $31 | 17,017 |
| 1869 | $12 | 629 | 1879 | 212 | 8,482 |
| 1870 | 65 | 3,983 | 1880 | ..... | 11,266 |
| 1871 | 2,191 | 7,069 | 1881 | ..... | 15,676 |
| 1872 | 4,102 | 5,893 | 1882 | ..... | 22,080 |
| 1873 | 981 | 11,522 | 1883 | 274 | 25,708 |
| 1874 | 813 | 13,802 | 1884 | 16,360 | 19,399 |
| 1875 | 100 | 8,509 | 1885 | 12,798 | 15,071 |
| 1876 | ..... | 9,013 | | | |

## CEMENT.

*Kinds made.*—No new varieties have been developed, the product still consisting primarily of the natural rock cements in by far the largest proportion, and also furnishing the base from which is made the artificial description commonly known as American Portland. Nor has the use of the domestic article extended to any new outlets, except, possibly, to be handled a little more freely as a mixture with imported cement in the production of drain and sewer pipe. The consumption of pipe thus made is not of a general character, and is confined principally to districts where the drainage waste is of a comparatively pure character and free from acids and other rapidly destroying agents. Quality has shown about the usual difference according to the locality in which it is made, but every manufacturer has sought to sustain his former standard, and improve it if possible, in order to compete with foreign supplies. All hydraulic cements require an especially pure dry atmosphere, yet even that will not effectually retard deterioration in quality. It has been shown by long and constant experience that both domestic and foreign cements, when allowed to remain in store for a long period, no matter how dry the location, are sure to absorb some moisture and undergo chemical changes that must gradually impair their setting and hardening qualities. On the other hand, however, there is danger that underburned cement, especially the artificial product, may contain an excess of free caustic lime that can only be removed by careful air slaking, and would seriously threaten the solidity of work upon which it might be used if it passed directly from the factory into consumption.

*Production.*—The production of cements during 1885 was somewhat irregular. The works in many cases opened the season almost without orders, and made, in consequence, quite an accumulation of stock, but subsequently the calls were so liberal as to exhaust all stores and force the mills to full capacity up to the period of frost. The loss of business during the first part of the year was, in a measure, due to successful competition on the part of the foreign product, yet the production was afterwards increased to such an extent as to bring the final results somewhat in excess of 1884. The value has averaged lower; so low, in-

deed, as to scarcely leave a margin to the manufacturer, yet no serious losses are known to have occurred, and the industry as a whole is apparently upon a sound financial basis. In making up the figures of production it has been found possible to reach desirable and reliable information at all the principal centers of manufacture, and the resulting estimate approximates as nearly as possible to exact returns. In the Rosendale district, Ulster county, New York, the output was 1,750,000 barrels; in the Louisville district, 850,000 barrels; in the Buffalo and Akron districts, 600,000 barrels; Utica, Illinois, 300,000 barrels; Milwaukee, Wisconsin, 250,000 barrels; and scattering, 250,000 barrels. This makes a total of 4,000,000 barrels, and compares as follows with the output of previous years:

*Production of cement made from natural rock in the United States from* 1882 *to* 1885.

| Years. | Barrels of 300 pounds. | Average price per barrel. | Total Value. |
|---|---|---|---|
| 1882 | 3,165,000 | $1.10 | $3,481,500 |
| 1883 | 4,100,000 | 1.00 | 4,100,000 |
| 1884 | 3,900,000 | .90 | 3,510,000 |
| 1885 | 4,000,000 | .80 | 3,200,000 |

With the exception of a small deposit upon the Potomac river, and additional works noted in the Rocky mountains, no new sources of supply have appeared, while one of the western firms has gradually gone out of production in consequence of its failure to preserve a merchantable standard of quality.

The artificial cements (American Portland) have followed the common course of nearly all structural materials during 1885, and have shown an increased production at a diminished cost. A natural expansion of the outlets and the introduction of new and improved machinery may be briefly mentioned as the main factors leading to the results noted, though at one or two new localities tentative efforts in the way of manufacture were sufficiently successful to add somewhat to the production and to promise continuation with further growth. While admission of a modifying cost was readily made by manufacturers, a great deal of reticence developed at every attempt to reach an exact figure, and an estimated valuation became necessary in consequence, and $1.95 per barrel was finally decided upon as a conservative average representation of all views, the output of stock for the year on the closest indication obtainable showing about 150,000 barrels of 400 pounds each. The great bulk of artificial cement is made in the vicinity of Allentown, Pennsylvania, a fair quantity produced at South Bend, Indiana, not seeking an open market but going into local consumption for the manufacture of sewer pipe, etc.

*Estimated production of American Portland cement from* 1882 *to* 1885.

| Years. | Barrels of 400 pounds. | Average price per barrel. | Total value. |
|---|---|---|---|
| 1882 | 85,000 | $2.25 | $191,250 |
| 1883 | 90,000 | 2.15 | 193,500 |
| 1884 | 100,000 | 2.10 | 210,000 |
| 1885 | 150,000 | 1.95 | 292,500 |

The total production of all kinds of cement during the past four years was about as follows:

*Total production of all kinds of cement in the United States from* 1882 *to* 1885.

| Years. | Barrels. | Value. |
|---|---|---|
| 1882 | 3,250,000 | $3,672,750 |
| 1883 | 4,190,000 | 4,293,500 |
| 1884 | 4,000,000 | 3,720,000 |
| 1885 | 4,150,000 | 3,492,500 |

*Imports.*—The additions to production of domestic cements did not check imports, but, on the contrary, the arrivals of foreign stock made further increase, and reached the highest point on record during the year 1885. The total amount for the United States will approximate 650,000 barrels of 400 pounds each. New York is the principal port of entry, and the only point at which reliable figures of imports could be found. These are given below with comparisons, and very fairly indicate the rapid development of the importation of cement during the past nine years. The average cost of importation during 1885 was, at a full estimate, $2.05 per barrel laid down on the piers at New York, a decline much greater than upon any description of the domestic production.

It would hardly be fair to accept the liberal addition to importations of cement during 1885, in comparison with the preceding years, as a true index of corresponding growth in actual consumption. The foreign "Portlands" of good standard quality have undoubtedly grown in favor, owing to their adaptability and indeed superiority for numerous descriptions of work, besides as a matter of economy. Influences other than natural demand, however, had considerable force in stimulating importation during 1885, the most noticeable of which were: the removal of duty on packages, low ocean transportation charges, and very strong competition among the importers. The last was the most unsatisfactory feature, as it brought into the country a large quantity of low-grade stock, a considerable percentage of which remained unsold at the end of the year, and some was forced off at a heavy loss. The foreign producers are becoming convinced of the necessity for a standard test and grading, and are arranging for that end. Portland cements are receiving some very critical scientific attention and their properties are

becoming better understood than any other similar product, a suggestion that might be taken into account by the manufacturers of domestic cements. An English scientist, after a detailed statement of methods and tests applied, reaches the following deductions as indicating the pre-requisites of a first-class cement:

"1. *Fineness.*—To be such that the cement will all pass through a sieve having 625 holes (25 by 25) to the square inch, and leave only 10 per cent. residue when sifted through a sieve having 2,500 holes (50 by 50) to the square inch.

"2. *Soundness.*—That a pat made and submitted to moist heat and warm water shall show no signs of blowing in twenty-four hours.

"3. *Tensile strength.*—Briquettes which have been gauged, treated, and tested in the prescribed manner shall carry an average tensile strain without fracture of at least 175 pounds per square inch at the expiration of three days from gauging, and those tested at the expiration of seven days from gauging shall show an increase of at least 50 per cent. over the strength of those at three days; but the briquettes broken at the seven days' test shall carry an average tensile strain without fracture of at least 350 pounds per square inch.

"Such a specification meets all requirements, and satisfies the peculiarities of nearly all cements, except perhaps the very quick setting ones, for which a slight variation in the tensile strength and the percentage of increase between the dates named would have to be made."

*Imports of cement at New York, in casks of 400 pounds.*

| Years. | From Great Britain. | From European continent. | Total casks. | Cost on pier per cask. | Total value. |
|---|---|---|---|---|---|
| 1877 | 47,632 | 10,818 | 58,450 | ..... | ..... |
| 1878 | 51,477 | 19,040 | 70,517 | ..... | ..... |
| 1879 | 80,834 | 25,212 | 106,046 | ..... | ..... |
| 1880 | 120,833 | 45,080 | 165,913 | ..... | ..... |
| 1881 | 149,486 | 73,186 | 222,672 | ..... | ..... |
| 1882 | 171,202 | 190,924 | 362,126 | $2.60 | $941,528 |
| 1883 | 158,602 | 143,363 | 301,965 | 2.70 | 815,306 |
| 1884 | 155,477 | 201,085 | 356,562 | 2.50 | 891,405 |
| 1885 | 187,955 | 250,860 | 438,815 | 2.05 | 899,571 |

The total imports (classed as "Roman" cement at the custom houses) into the United States since 1868 have been:

*Roman cement imported and entered for consumption in the United States.* 1868 *to* 1885, *inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Barrels.* | | | *Barrels.* | |
| 1868 | ..... | $10,168 | 1877 | ..... | $201,074 |
| 1869 | ..... | 9,855 | 1878 | ..... | 184,086 |
| 1870 | ..... | 18,057 | 1879 | ..... | 212,719 |
| 1871 | ..... | 52,103 | 1880 | ..... | 373,264 |
| 1872 | ..... | 172,339 | 1881 | ..... | 441,512 |
| 1873 | ..... | 209,097 | 1882 | 370,406 | 683,684 |
| 1874 | ..... | 286,429 | 1883 | 456,418 | 802,294 |
| 1875 | ..... | 261,741 | 1884 | (a)585,768 | 825,095 |
| 1876 | ..... | 247,200 | 1885 | (a)554,396 | 874,070 |

a Classed simply as cement; kind not specified.

*Rocky Mountain division.*—The works of the Denver Cement Company at Denver were run during a portion of 1885, but the production has not been very large. The cement produced by the company is of fair quality; it has been used in various buildings in Denver and has given very general satisfaction. The occurrence of the rock used in the manufacture has been given in previous issues of this report. Nothing of general interest developed in the business during 1885. Statistics of production could not be obtained from the manufacturers, and estimates are omitted as practically useless.

The Colorado Springs Stucco, Brick, and Cement Company, which manufactures plaster of Paris at Colorado City, is increasing the size of its plant, and proposes hereafter to produce hydraulic cement for the western markets. The material used in the production of the cement is found in abundance in the "Great Hogback" near Colorado City, and very convenient to the works. The combination of the manufacture of cement and plaster of Paris by one concern will probably enable the company to produce the former quite cheaply, so to compete with other Colorado companies, and with the Louisville and Portland cements.

*Pacific coast.*—Although a good hydraulic limestone has been found in California, and extensive works were put up near the town of Vallejo many years ago for manufacturing it into cement, very little of the latter has been made there for several years past, the English and eastern being preferred to the California article, for the alleged reasons that the latter has proved to be of an inferior quality. Some of the hydraulic limestone discovered a year or two ago near the town of Niles, Alameda county, has since been made into cement, which, it is claimed, equals the best made elsewhere. The quantity of cement received at San Francisco during a period of twenty odd years is shown by the table appended:

*Imports of cement at San Francisco.*

| Years. | Barrels. | Years. | Barrels. |
|---|---|---|---|
| 1864 | 13,322 | 1875 | 73,814 |
| 1865 | 26,270 | 1876 | 66,988 |
| 1866 | 34,360 | 1877 | 45,469 |
| 1867 | 31,666 | 1878 | 57,258 |
| 1868 | 31,954 | 1879 | 15,668 |
| 1869 | 54,697 | 1880 | 62,417 |
| 1870 | 42,377 | 1881 | 65,695 |
| 1871 | 32,602 | 1882 | 99,208 |
| 1872 | 54,746 | 1883 | 151,807 |
| 1873 | 61,911 | 1884 | 152,500 |
| 1874 | 79,435 | 1885 | 167,000 |

The prices of cement in the San Francisco market were at the beginning of 1886 as follows: California, $2 per barrel; Rosendale, $2.25 per barrel; and Portland, $3.25 per barrel.

## LIME.

While the sources from which supplies of lime are drawn, continue practically immeasurable, there is a significant tendency towards the concentration of the production to certain localities. Increased facilities for transportation, with a natural sequence in lower cost of handling and delivery, permits the location of extensive works upon beds of excellent limestone which were previously neglected for want of an accessible market; this concentration and cheapening of production must gradually overshadow the old and somewhat crude systems, except in the most isolated localities.

With the actual output of some of the important manufacturing districts as a guide, and assisted by careful estimates from sections where no records are as yet preserved, an estimate of the total production of the United States for 1885 has been reached and placed in comparison with that of three preceding years, as follows:

*Estimated production of lime in the United States from* 1882 *to* 1885.

| Years. | Barrels of 200 pounds. | Average value at kiln. | Total value. |
|---|---|---|---|
| 1882 | 31,000,000 | $0.70 | $21,700,000 |
| 1883 | 32,000,009 | .60 | 19,200,000 |
| 1884 | 37,000,000 | .50 | 18,500,000 |
| 1885 | 40,000,000 | .50 | 20,000,000 |

The increase of 3,000,000 barrels would have been exceeded but for certain local influences which have led to a curtailment of production in two or three districts of considerable manufacturing importance. All authorities agree that at 50 cents per barrel a fair average value is shown, there being little if any difference in that respect from the preceding year, while in quality some improvement may be credited. The most decided increase during the year was in the same direction noted in 1884. Following largely the Missouri and Mississippi valleys and making some growth on the Pacific coast, it spread somewhat more freely over Texas and made a slight showing in other Gulf States. Virginia and West Virginia are assuming greater importance as contributors to the general supply, and in the Housatonic valley, near Canaan, Connecticut, another considerable supply has become available. Of the latter a local consumption has been common for many years, but a new and improved plant and ample means for moving the product will greatly extend the area of distribution.

The following analysis of the Canaan, Connecticut, limestone has been furnished:

*Analysis of lime from Canaan, Connecticut.*

| | Per cent. |
|---|---|
| Carbonate of lime | 92.66 |
| Magnesia | 1.76 |
| Oxide of iron and alumina | .14 |
| Silica | 5.44 |
| Total | 100.00 |

The use of lime in the manufacture of glass amounts on an average to about 11,000 long tons, and of limestone, some 33,000 tons are consumed. It is more than likely that those amounts were not quite reached during 1885, owing to curtailed glass production during a portion of the year.

*Imports and exports.*—The imports of lime have proved moderate, and in the main composed of selected varieties peculiarly adapted to some special work. At the port of New York, however, about 15,500 barrels of building lime were received as an experiment and secured fair favor. The cost on the pier was about 50 cents per barrel. The custom-house records still fail to make any division between lime and cement in statistics of exports, but the proportion of lime is unquestionably very small, probably not more than 10 per cent. of the exports named.

*Lime imported and entered for consumption in the United States.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Barrels.* | | | *Barrels.* | |
| 1869 | | $10,800 | 1878 | | $14,344 |
| 1870 | | 9,063 | 1879 | | 13,196 |
| 1871 | | 11,315 | 1880 | | 15,852 |
| 1872 | | 11,014 | 1881 | | 24,968 |
| 1873 | | 8,260 | 1882 | 73,093 | 36,879 |
| 1874 | | 10,964 | 1883 | 76,889 | 41,224 |
| 1875 | | 7,328 | 1884 | 53,505 | 26,370 |
| 1876 | | 7,367 | 1885 | 54,676 | 28,270 |
| 1877 | | 12,823 | | | |

*Lime and cement of domestic production exported from the United States,* 1864 *to* 1885 *inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Barrels.* | | | *Barrels.* | |
| 1864 | | $86,386 | 1877 | 78,341 | $97,923 |
| 1865 | | 94,606 | 1878 | 82,507 | 98,334 |
| 1870 | 31,175 | 61,490 | 1879 | 60,657 | 74,097 |
| 1871 | 21,575 | 51,585 | 1880 | 41,989 | 52,584 |
| 1872 | 39,686 | 69,218 | 1881 | 57,555 | 83,598 |
| 1873 | 27,873 | 52,848 | 1882 | 67,030 | 100,169 |
| 1874 | 41,349 | 69,080 | 1883 | 74,687 | 120,156 |
| 1875 | 64,087 | 98,630 | 1884 | 65,768 | 108,437 |
| 1876 | 53,827 | 77,568 | 1885 | 79,627 | 127,523 |

*Limestone flux.*—The annexed estimates of the amount and value of limestone used in iron smelting from 1882 to 1885, inclusive, have been received from Mr. James M. Swank. Large quantities are also consumed in lead smelting, but estimates received are very indefinite and consequently omitted as practically useless.

*Limestone used as flux in iron smelting in the United States from* 1882 *to* 1885.

| Years. | Quantity. | Average cost at quarry. | Total value. |
|---|---|---|---|
| | *Long tons.* | *Per ton.* | |
| 1882 | 3,850,000 | $0.60 | $2,310,000 |
| 1883 | 3,814,273 | .50 | 1,907,136 |
| 1884 | 3,401,930 | .50 | 1,700,965 |
| 1885 | 3,389,313 | .50 | 1,694,656 |

From the chief inspector of mines of the State of Ohio the following information is obtained: In 1884 the only record obtained was of limestone quarried for flux in smelting iron, amounting to 183,305 short tons. In 1885, however, an effort was made to extend research to building stone and the quantity burned for lime, with the appended results.

*Production of limestone in the State of Ohio during* 1885.

| | Short tons. |
|---|---|
| For flux in iron smelting | 141,957 |
| For building purposes | 311,971 |
| For lime burning | 662,447 |
| Total | 1,116,375 |

*Pacific coast.*—Mr. Yale furnishes the following:

The Pacific division of the continent abounds in limestone, there being enough produced in all the States and Territories of the West for local consumption. At one time there was thought to be but little stone of this kind in Oregon and in Washington Territory, but more careful search has brought to light an abundance of it there, and these regions have for the past two years been making enough lime for their own use, and have begun to ship it to California, the most of that exported coming from the vicinity of Puget sound.

California is prolific in limestone of every variety and of the best quality. The most extensive belt of this stone stretches north and south along the western foothills of the Sierra Nevada for a distance of nearly 150 miles, reaching from Mariposa county to Butte. It varies from a quarter of a mile to 3 miles in width, the rock near its southerly end, in the vicinity of Columbia, consisting of marble of good quality, and easily quarried. From 60 to 80 miles farther west a metamorphic limestone occurs in the Coast Range mountains, whence are

obtained the supplies for the seaboard counties, the inland counties being supplied from the foothill belt, large quantities from the kilns there being also shipped to San Francisco. In El Dorado county, at Alabaster Cave, on this belt, are located the Alabaster lime works, consisting of a "Monitor" kiln capable of burning 3,000 barrels per month. The lime made is noted for its purity and whiteness, and is much used for the purification of gas. The extensive kilns erected a few years ago near Clipper Gap, Placer county, were purchased soon after by the H. T. Holmes Company, owners of the Alabaster works, and have since remained closed.

The most of the lime in the Coast Range is burnt near the towns of Santa Cruz and Felton, Santa Cruz county, where several companies have put up large works, facilities for manufacture and shipping being extremely good there. The rock is abundant, of the best kind, and easily quarried. Wood and water are plentiful and transportation to San Francisco can be had by either water or rail.

The three large companies operating here each make between 40,000 and 50,000 barrels of lime per year. Each gives employment the year round to about 40 men, wood choppers and teamsters included, at wages of $1.50 per day, though much of the work is done on contract. During the past two years lime burning has been carried on more generally over the State than was formerly the case, much having been burnt of late in the southern counties, where very little was made previously, owing to the limited demand, and in most localities, a scarcity of fuel. With the rapid increase in population of that section of the State, this industry has reached considerable proportions, there being no lack of good limestone there.

Several years ago the Hydrocarbon works, at Colton, San Bernardino county, began using crude petroleum as a fuel for burning lime. Although they have not abandoned its use, the experiment has not proved entirely satisfactory, owing to the great cost of this substance. Whether it can continue to be used with economy, the company has not yet determined, though the conditions favoring its employment are here as good as can be hoped for in the State, crude petroleum being cheap, but other fuel costly.

The production of lime in California amounted last year to about 220,000 barrels. The receipts at San Francisco were 160,000 barrels. Formerly some small lots of lime were exported from California to Oregon, Washington Territory and the Sandwich Islands. None, however, is sent away at present, these countries all making what they require at home. That made in the Sandwich Islands is burnt from coral. Though lacking in strengh, this lime is of fair quality. The price of lime in San Francisco is lower at present than ever before, not exceeding $1.50 per barrel.

## CLAYS.

In "Mineral Resources of the United States, 1883 and 1884," page 676 *et seq.*, will be found an exhaustive report upon the clays of the United States. Localities where deposits occur, an enumeration of articles manufactured from clay, together with a description of the methods of manufacture, and such reliable statistics as could be obtained, were given in detail, and nothing of importance can now be added beyond such information as has become accessible relating to the course of production during the year 1885.

As a basis for calculating the value of the total production of clays the assumption is made that the census report of 1880, naming $40,000,000 as the value of articles manufactured from clay in the United States, was approximately correct, and it now appears very safe to estimate an increase of fully 25 per cent. in the aggregate, and to place the present value at $50,000,000. In considering this amount an allowance must be made for a modified plane of cost as compared with that ruling at the period when information for the census report of 1880 was in course of collation, and it will be patent that the percentage of increase in quantity is still greater. Except in a few localities there was a positive absence of detail that would permit of a proper apportionment of the estimates to the various articles unnumbered among the products of clay; but building brick, general pottery, drain pipe and tile, terra cotta, and sewer pipe, in the order named, appear to show the greatest increase. Ornamental pottery, encaustic tiling, fancy pressed brick, etc., are all gaining, on account of marked improvement in American methods of manufacture, which allow American potters to compete quite successfully with foreign wares.

Carrying out the plan adopted in the last volume of "Mineral Resources," a compilation of such statistics as could be reached is given, with such additional information as may appear pertinent and interesting through the developments of the production of 1885.

Among the new deposits reported during 1885 may be noted a fine pottery clay in Lincoln parish, Louisiana; an 8-foot vein of fireclay at Saltsburgh, Pennsylvania; and a 9-foot vein of fine fireclay at Evansville, Indiana.

The quantity of fireclay mined in the State of Ohio in 1884 was 168,208 short tons, and the production for 1885 amounted to 153,756 short tons.

A new bed of fireclay has also been discovered at New Ross, Nova Scotia.

GENERAL CONDITION OF MANUFACTURES OF CLAY AND PRODUCTION STATISTICS.

*EASTERN DIVISION.*

*Common brick.*—Were it possible to obtain a comparative ratio of increase in production of all building material during the year 1885, it is almost a certainty that common brick would be found far in the van. Several influences have led up to this result, general details of which are unnecessary in this connection; but they may be summarily noted as embodying improved quality at lower cost, which attracted those seeking the cheapest material. The production has been aided to some extent by public work of various descriptions put under way in many parts of the country, but in the main the building of dwellings and other edifices afforded the largest consumption. Brick makers have contributed to the sale of their product very materially by setting a higher standard of quality and maintaining it; this feature was the more commendable from the fact that no new methods of manufacture were introduced, and the result was attained simply by increased care in handling the material through its various stages of manufacture. Naturally the older localities have shown this tendency in the highest degree, but it has been followed out so far as practicable in the newer works, partly as a competitive necessity. In the East there has been a revival of work on many clay beds that have been neglected for some time, and new deposits opened; a slight increase is evident in the States of New York, New Jersey, and Pennsylvania, quite a general growth in the producing States of the West, and as a very significant feature, an increase in the States of Tennessee, Florida, Georgia, and Texas. No idea of the quantity made in the latter section has been obtained, nor for that matter can a clear conception of the total amount for the United States be positively decided upon, owing to the innumerable small productive stations scattered throughout the country and turning the output into an immediate local exhaust. If the census figures placing the production for 1880 at 3,822,362,000 bricks is approximately correct, it is safe to estimate the total product of the United States for 1885 at 4,585,000,000 bricks, an increase of about 20 per cent. beyond the census year, most decided, however, during the last two years of the period covered. In the matter of value quite a wide difference of opinion has been encountered, but taking the average figure from those evidently calculating closest to actual productive cost, $25,000,000 would be a maximum estimate of value for all kinds of building brick made during 1885, a separation of common and "fronts" or pressed brick having been refused or overlooked by the majority of manufacturers in naming a "cost" price. In a few States where official statistics are prepared and other reliable sources of information can be reached, the figures of production are sufficiently authentic to be useful as a comparison, and probably convey some idea of the general growth of the manu-

facture of brick throughout the country, and upon that surmise the following statement has been prepared:

*Production of building brick in five States for the years* 1883, 1884, *and* 1885.

| States. | 1883. | 1884. | 1885. |
|---|---|---|---|
| New York | 700, 000, 000 | 825, 000, 000 | 900, 000, 000 |
| New Jersey | 200, 000, 000 | 225, 000, 000 | 250, 000, 000 |
| Pennsylvania | 300, 000, 000 | 325, 000, 000 | 350, 000, 000 |
| Ohio | 300, 000, 000 | 325, 000, 000 | 350, 000, 000 |
| Indiana | 275, 000, 000 | 300, 000, 000 | 350, 000, 000 |

*Production of common brick in Indiana.*

| Years. | Establishments. | Capital employed. | Value of product. | Hands. employed. | Wages. |
|---|---|---|---|---|---|
| 1879 (*a*) | 406 | $448, 200 | $995, 310 | 1, 928 | ..... |
| 1882 | 173 | 346, 550 | 993, 425 | 1, 357 | $359, 870 |
| 1883 | 396 | 861, 872 | 2, 170, 277 | 3, 012 | ..... |
| 1884 | 415 | 667, 915 | 2, 309, 922 | 3, 242 | 1, 132, 335 |

*a* Estimated; evidently too high.

In New Jersey a few new clay beds have been opened and work commenced, but it was impossible to obtain any statistics of the addition to capacity or the general aggregate of production. The wages paid to workmen in New Jersey during 1884 averaged per week: $14 to molders, $12 to pressers, and $11.37 to kilnsetters. Bricklayers secured $18.75 per week, and those rates did not differ materially during 1885. In other States, so far as any attempt at statistics has been made, the average cost differs only fractionally from the rates named above. In tests as to durability the terra-metallic bricks generally prove best. They are substantially the same as the English blue bricks; they are hard and tough, and have stood a crushing test of over 575 tons to the square foot. Quite extensive use has been made of them in foot paving, for which they appear peculiarly well adapted, in the construction of bank vaults, for engineering works, etc. During 1885 several experiments were made to test the strength of red brick. On a base area of 37.47 square inches there was an average stress of 255,950 pounds, when the brick cracked slightly. The pressure was equal to 6,830 pounds per square inch, or 439.2 tons per square foot, and the result may be accepted as a fair indication of the resistance of average brick to crushing force.

*Hollow bricks*, in common with fireproofing, were somewhat influenced by changes in the character of buildings constructed at former points of consumption, but were urged into notice in other directions and met with sufficient favor to keep the production up to the aggregate of 1884, at least, though at a lessened price. Suggestions as to the number made and value are too vague for use at this time. New Jersey turns

out the largest amount, but establishments making kindred goods in western States are commencing to compete in a small way.

*Pressed brick.*—Some unimportant additions to the productive capacity were made, but few if any really new deposits of clay developed showing the standard of quality required in the manufacture of pressed and ornamental brick. The localities most prominent in making the descriptions under consideration, therefore, remain about the same as those named in the last report, with the exception that Trenton, New Jersey, should be added to the list as an old contributor of a very desirable article, with a quality about the same as "Philadelphias." The estimate of the output of pressed brick has been hampered slightly by a tendency to secrecy among a few manufacturers, but in round numbers 235,000,000 is the estimate decided upon, which is in fair proportion with common brick. The taste for elaboration in brick work, both exterior and interior, has led to the introduction of a great variety of colors; indeed almost any shade desired can now be produced on order, while the popular or standard hues are turned out for regular stock in some establishments. For producing encaustic colors in ornamental bricks the shading oxides are mixed with the clay in quantities of 7 to 10 per cent. Enameled brick are colored either under the glaze or in the glaze. When the application is to be made under the glaze it is customary to dip the burned bricks into a slip of colored clay composed, in most instances, of one part colored glass, ground, and two parts clay, the latter causing adhesion of the slip, and the brick is then fired, or, after being allowed to dry, is coated with a transparent glaze and then fired. When the color is to be applied in the glaze the brick is dipped into a transparent colored glaze, made of siliceous sand, salt, and oxide of lead, besides the coloring oxide. The one face or head to become the exposed surface of the walls when laid is usually treated in glazing and enameling. "Rights and lefts" are also made by subjecting one head and face to the necessary process, and the brick so prepared are used for the respective corners to which they are adjusted, for door jambs, reveals or windows, etc. For general outside or exposed work the colors most used are black, brown, chocolate, and buff, with brighter shades added in enameling, and for expensive interior decorative purposes there may be added gray, olive green, bronze green, pink, carmine, orange, purple, violet, turquoise, and indigo.

A few ornamental bricks are imported, but principally upon orders, as the wants of the open market are fairly well filled from the domestic product. French manufacturers have utilized the waste sand of glass factories for the production of siliceous bricks of fine white color which are very strong and durable for architectural purposes. The sand is subject to immense hydraulic pressure and then baked in furnaces at a high temperature. The specific gravity of the bricks is extremely low, and they will resist the action of the sun, rain, and acids. German

chemists are also reported to have introduced a method for obtaining a product superior to ordinary bricks and tiles in resisting the action of acids, humidity, etc., and especially well adapted for the construction of sewers. After drying and grinding the clay, a mixture is made as follows:

*Mixture for bricks and tiles.*

| | Per cent. |
|---|---|
| Clay | 91.50 |
| Iron filings | 3.00 |
| Table salt | 2.00 |
| Potash | 1.50 |
| Elder or willow wood ashes | 2.00 |
| | 100.00 |

The whole is then heated to a temperature varying from 3,360° to 3,630° F. At the end of four or five hours the mixture is run into molds, then rebaked in ovens (always protected from air) at 840° to 930° F. The product may be colored by adding to 100 parts of the above 2 parts of manganese dioxide for a violet brown, 1 part of manganese dioxide for a violet, 1 part of copper ashes for green, 1 part arseniate of cobalt for blue, 2 parts of antimony for yellow, and 1½ parts of white arsenic and 1 part oxide of tin for white.

Unfortunately no report of cost is given for either of the two new products named.

*Firebrick.*—There was no incentive calculated greatly to stimulate the manufacture of firebrick during 1885. The dull and unpromising condition of the industries upon which firebrick depends for a market, small profit to the maker, and competition from the importer, all had a tendency to hold production in check, yet the reduction in output at the older establishments was really quite small, and with a few new manufacturers in the field the aggregate output exceeded but did not differ very materially from the product of 1884. Ohio, Pennsylvania, and New Jersey remain the principal producing States, but no complete returns can be obtained as to the amounts made. Careful estimates indicate the following results:

*Estimated production of firebrick for* 1883, 1884, *and* 1885.

| | 1883. | 1884. | 1885. |
|---|---|---|---|
| Ohio | 23,000,000 | 25,000,000 | 25,000,000 |
| Pennsylvania | 55,000,000 | 50,000,000 | 50,000,000 |
| New Jersey | 21,000,000 | 20,000,000 | 20,000,000 |
| Scattering | 7,000,000 | 8,000,000 | 10,000,000 |
| Total | 106,000,000 | 103,000,000 | 105,000,000 |

During 1884 the production of firebrick was somewhat retarded and the sale impaired by a liberal offering of foreign-made stock at un-

usually low rates, the result of mere nominal freight charges and a determined effort to force the American market by some of the European makers. In 1885, however, importers were in a much more conservative mood and brought out supplies only on actual orders. The imports are principally at New York, and at that port the quantity received from foreign countries in 1885 was 1,081,625; in 1884, 1,524,000; in 1883, 1,250,135, and in 1882, 2,831,000 bricks.

As an indication of the relative position of values on January 1, for three years, the following comparison of prices is given:

*Prices of firebrick in the New York market, per thousand.*

| Kinds. | 1884. | 1885. |
|---|---|---|
| Welsh | $30.00 to $35.00 | $25.00 to $30.00 |
| English | 25.00 30.00 | 25.00 30.00 |
| American, No. 1 | 33.00 35.00 | 30.00 35.00 |
| American, No. 2 | 25.00 30.00 | 25.00 30.00 |

*Door knobs, porcelain, hardware, and telegraph insulators.*—Statistics of the production of these articles may be considered as almost impossible, but according to all trustworthy accounts quite as large quantities were made as during 1884, and possibly an excess, owing to their staple character and general consumption. Ohio and New Jersey turn out the largest quantity, but manufacturers of whiteware pottery in other sections are commencing to make small amounts, and if the ventures prove successful they will increase the production.

*Glass pots and retorts.*—Gas retorts have an even yearly production carrying with it no particular significance. Glass pots are, to a very large extent, made at the works where they are used, though in the West two or three establishments make them a specialty, and on orders have increased the output during 1885 by some 5 or 10 per cent.

*Pottery, etc.*—The location of clay deposits, and points of production remain substantially the same as set forth in detail on pages 698, 699, and 700 of "Mineral Resources of the United States, 1883 and 1884," no additions of importance having been made during 1885, so far as information is received. The absence of statistics from other than four of the principal States engaged in the manufacture of pottery, earthenware, etc., still impedes the effort to arrive at a really satisfactory conclusion respecting the value of the total output, but recent estimates have named $10,000,000 as representing the amount of capital employed, and $10,000,000 as the value of pottery and encaustic tiling produced in 1885. The condition of trade has been somewhat unsettled, with prices generally ranging lower and margins smaller to the manufacturer; for it was difficult, and in many cases simply impossible, to modify the cost of production to correspond with the selling plane, owing to the high scale of wages obtained by the skilled labor which it was necessary to retain. Competition also has been quite sharp, and some

of the smaller potteries producing only the ordinary qualities of stoneware were compelled to shut down. Generally, however, the pottery production of the country has obtained an unassailable position as an established, profitable, industry. Especially noteworthy is the universal and more or less successful effort to increase the variety and elevate the standard of the better descriptions; and home production on a simple matter of quality even now, makes importations unnecessary, except in compliance with sentiment. The amateur decorator produced the incentive upon which the experimenter began, and from the latter came the rapid development of the capacity of the country into its present magnitude. At Cincinnati, Ohio; Trenton, New Jersey; and at Baltimore, Maryland, work of the most artistic character is now turned out. At Baltimore particularly great progress has been made during the year in increasing the assortment and bettering the condition of the pastes formed from clays of local deposits, and the wares thus produced have met prompt markets even in face of a comparatively dull general trade. Stoneware and earthenware were probably produced with less freedom in 1885, owing to the unprofitable character of the trade and its natural influence upon the numerous small manufacturers engaged, but whiteware made some increase in the volume of the output of plain white "C. C." and ironstone. No positively new works have come into existence, but old establishments made additions to their plants, nearly all for the purpose of raising the standard of quality in both plain and ornamental ware. The number of kilns now in operation in the entire country is not far from 300, with a capital of $9,000,000 to $10,000,000, and paying annually some $5,000,000 to the workmen employed.

A glance at the imports of earthen and china ware of late years shows a decided falling off, and while this is to some extent attributable to restricted comsumption, competition with the American product is the more potent factor through which the shrinkage has been brought about. The imports of earthen, stone, and china ware for the fiscal years ending June 30, 1883, were $8,693,273; for 1884, $4,368,531; and for 1885, $4,666,175. A more comprehensive exhibit is given in the following table, recently prepared and published by *Bradstreet's*, a New York trade journal:

*Details of pottery and china ware importations.*

| | Values fiscal years ending June 30— | | | Values last six months (*a*)— | |
|---|---|---|---|---|---|
| | 1870. | 1880. | 1885. | 1885. | 1884. |
| Brown earthen and common stone ware. | $47,457 | $31,504 | $44,701 | $416,789 | $625,045 |
| China, porcelian, parian ware (plain) ... | 420,442 | 334,371 | 823,334 | | |
| China, porcelain, parian ware (decorated) ..... | 530,804 | 1,188,847 | 2,834,718 | 1,740,943 | 1,869,064 |
| All other earthen, stone, or crockery ware. | 3,461,525 | 3,945,666 | 963,422 | 611,408 | 420,569 |
| Total..... | 4,460,228 | 5,500,388 | 4,666,175 | 2,769,140 | 2,914,678 |

*a* Calendar years.

Between 1870 and 1880 the increase in the value of importations was $1,040,160, or about 23 per cent., and the falling off of imports from 1880 to 1885 amounted to $834,818, or 15.2 per cent. From July 1 to December 31, 1885, the decline in the value of imports was $145,538 as compared with the corresponding period in 1884. It is particularly significant as indicating the growth of the American industry that from 1880 to 1885 the decline in the imports of the plainer or common varieties was $2,480,600, and while the fine and decorated descriptions during the same period made a considerable increase, they too appear to commence shrinkage before the skill of the domestic producer, as shown in a reduced import of $128,121 for the last six months of 1885 against the same time in 1884.

*Drain tile.*—A steady growth in the production of drain tile has taken place, more decided, however, in the western than in the eastern States. In the latter section the farmers think old-fashioned ditching, etc., affords all the relief they require, but in the West new and improved methods are readily adopted by the agriculturist and the proper drainage of lands is very generally conceded to be best accomplished through the medium of tiling. Manufacturers are also aiding consumption by more careful methods in production, gradually studying the requirements of different soils, and making qualities adapted thereto, and while there is still room for vast improvement, a step in the right direction has unquestionably been made. Competition has also kept prices low and added another feature calculated to increase the use of tile among the farmers. It is a somewhat singular circumstance that sections in which the most benefit is derived from the use of drain tile contain the clays from which it is made, and this in natural order leads to many small local establishments manufacturing solely for a small area. Of these and of many of the more extensive producing localities and States no record even for an estimate can be obtained, but the principal manufacturing States furnish a clear statement from which an idea of the general growth of the industry may be formed.

The production of Indiana is reported as follows:

*Production of drain tile in Indiana.*

| Years. | Number of establishments. | Capital employed. | Value of product. | Hands employed. |
|---|---|---|---|---|
| 1879 | 297 | $456,489 | $623,720 | 948 |
| 1880(a) | 486 | 700,000 | 900,000 | 2,187 |
| 1882 | 261 | 491,130 | 764,345 | 1,086 |
| 1883 | 387 | 759,562 | 1,133,515 | 1,517 |
| 1884 | 513 | 958,920 | 1,659,820 | 1,880 |

a Estimated; evidently too high.

During 1885 there was a still further growth, but in a somewhat lessened proportion.

*Terra cotta.*—While information as to the total amount of this material made during 1885 is very meager, sufficient has been elicited during the course of inquiry to indicate a further growth of the industry. New Jersey produces by far the largest quantity, followed in turn by Massachusetts, Illinois, Maryland, and Ohio, the latter State having in the last report received credit for a larger proportion than properly due under this classification. All the old established works have equaled the output of 1884, and some have reached an excess, while new plants of considerable magnitude were projected in the West, with an intention of commencing operations in time for the season of 1886. The use of terra cotta appears to have grown in about the same proportion as brick, as the use of the two materials in combination is not only a present fashion, but recognized upon a basis of economy, durability, and safety, with a gain rather than loss in the matter of attraction. Low cost, resistance to climatic changes, and ability to withstand fire, coupled with its adaptability to almost any desired style of trimming, has made the article one of the most popular for general building operations, and it is extending over a much wider area of consumption. The use of terra cotta is not free from objection when placed in position as a constructive material alone, or as an ornament when injudiciously applied, but as the faults are principally of an architectural character they are likely to be overcome by time and experience. Some excellent effects for interior work were brought out during the year, including beautiful designs for fireplaces, mantels, and hearths to match, and better appliances in the way of machinery have been introduced with most satisfactory results. The value of the terra cotta produced in New Jersey in 1883 was about $440,000, in 1884 well up to $450,000, and in 1885 not less than $500,000, with the amount of actual work really accomplished greater than represented by the mere difference in value, owing to modified cost of production.

*Terra-cotta lumber* has not become established as an article of practical value.

*Fireproofing.*—The production has been of an irregular character, with some conflict of opinion as to quantity, but the probabilities are in favor of a shrinkage as compared with 1884. The result was in no instance attributed to loss of confidence in the article, but principally to difference in the character of buildings constructed at some of the principal points of consumption. The bulk of the manufacturing is in the States of New Jersey and Pennsylvania, but Ohio is increasing somewhat, and other western States are experimenting.

*Roofing tiles.*—These have a somewhat irregular consumption, as they are used principally for fancy and striking effects upon detached structures, and as a rule are made only upon orders. Production in consequence runs close to the outlet, and the indications are that there was little if any increase during 1885. The material was certainly more in favor in some localities at least, but it is thought that it was scarcely

urged into the prominence it deserved, and competition will probably be stimulated, as in addition to the works in New Jersey and Ohio, a new plant of considerable magnitude has been made at Indianapolis, Indiana, intended to produce a superior article at a low cost.

*Sewer pipe.*—Ohio is still considered the principal producing locality, with New York next; the output of the two States for 1885 amounted to fully $4,500,000, and while that sum does not exceed former annual estimates in point of valuation, it represents a larger quantity of pipe owing to lower cost. New Jersey will probably run about $400,000, but with no noticeable tendency to increase, as the western producer is a strong and successful competitor in all the markets to which New Jersey is tributary. Several other States are included in the list of producing localities from which it has been found impossible to obtain anything in the form of reliable statistics, but there is some indication of an increase for Illinois and Indiana in the order named. A very considerable increase in the manufacture of cement pipe has commenced to develop as the result of the large importation and cheapness of foreign cements. These used in conjunction with domestic cements produce a very good article in the way of sewer pipe, though not of a character to resist the action of powerful acids and similar agents to which the vitrified pipes are impervious. A small quantity of sewer pipe is imported yearly, but there appears to be no record of the amount, nor is it of great importance.

### *ROCKY MOUNTAIN DIVISION.*

The manufacture of articles from clay in the Rocky Mountain district is limited to Colorado, in establishments located at Denver and Golden. The very imperfect character of the records kept by the manufacturers renders any definite statement of production impossible. While crucibles, scorifiers, muffles, etc., are regularly made, it cannot be ascertained how many of each were produced in 1885.

The amount of fireclay mined from 1880 to 1885 was about as follows:

*Fireclay used by the Colorado works.*

| Works. | Location. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|---|
| | | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| Cambria Brick and Tile Company | Golden | ..... | 2,000 | 3,000 | 3,000 | 500 | ..... |
| G. A. Duncan & Co | do | 4,000 | 6,000 | 9,000 | 10,000 | 12,000 | 15,000 |
| Golden Brick and Coal Company | do | 5,000 | 4,500 | 960 | 750 | 1,200 | 800 |
| Denver Fireclay Company | Denver | 1,200 | 1,200 | 1,500 | 1,200 | 3,200 | 4,500 |
| Denver Firebrick Company | do | ..... | ..... | 4,000 | 1,600 | ..... | ..... |
| Total | | 10,200 | 13,700 | 18,460 | 16,550 | 16,900 | 20,300 |

Pottery clay of fair quality occurs at several points on the "Great Hogback" in Colorado, but only drain pipes, tiles, flower pots, and crude manufactures are now produced from it. The Golden, Brick and Coal Company is the only concern now working pottery clays. The system of book keeping practiced by the clay companies is of such a

character that no satisfactory statistics could be obtained. It is hoped taht through the efforts of the Denver Chamber of Commerce good and complete statements of both pottery and fireclays can be published in the next volume of the "Mineral Resources."

### IMPORTS AND EXPORTS.

As will be seen from the following tables, there is a considerable importation of clay and its products, especially china, porcelain, etc., and a small export trade:

*Clay imported and entered for consumption in the United States,* 1867 *to* 1883, *inclusive.*

| Fiscal years ending June 30— | Fuller's earth. | | Kaolin. | | Unwrought pipeclay and fireclay. | | Total value. |
|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Long tons.* | | *Long tons.* | | *Long tons.* | | |
| 1867 | 280.25 | $3,113 | ..... | ..... | 6,383.75 | $72,204 | $75,317 |
| 1868 | 211.00 | 2,522 | ..... | ..... | 8,384.75 | 66,958 | 69,480 |
| 1869 | 324.10 | 3,587 | ..... | ..... | 12,963.75 | 84,645 | 88,232 |
| 1870 | 239.40 | 2,619 | ..... | ..... | 8,014.15 | 76,057 | 78,676 |
| 1871 | 290.20 | 3,383 | ..... | ..... | 10,900.48 | 103,144 | 106,527 |
| 1872 | 274.00 | 3,358 | ..... | ..... | 13,081.20 | 128,130 | 131,488 |
| 1873 | 251.18 | 2,978 | 1,378.30 | $13,091 | 12,883.82 | 141,927 | 157,996 |
| 1874 | 277.20 | 3,440 | 89.21 | 1,378 | 12,909.14 | 147,782 | 152,600 |
| 1875 | 300.06 | 3,694 | 130.47 | 1,977 | 10,374.65 | 116,307 | 121,978 |
| 1876 | 246.73 | 3,097 | 142.00 | 2,152 | 11,799.12 | 126,738 | 131,987 |
| 1877 | 400.00 | 4,460 | 204.26 | 3,009 | 11,680.14 | 129,016 | 136,485 |
| 1878 | 335.07 | 4,095 | 3,499.30 | 38,899 | 9,406.74 | 95,877 | 138,871 |
| 1879 | 361.21 | 4,269 | 4,774.60 | 45,272 | 8,477.80 | 87,948 | 137,489 |
| 1880 | 578.00 | 6,925 | 7,823.66 | 67,740 | 11,899.80 | 117,350 | 192,015 |
| 1881 | 267.55 | 3,207 | 6,887.37 | 66,654 | 12,444.28 | 123,545 | 193,406 |
| 1882 | 908.27 | 11,444 | 13,954.85 | 135,448 | 12,181.39 | 119,620 | 266,512 |
| 1883 | 1,241.27 | 14,309 | 12,870.60 | 115,492 | 7,841.32 | 74,673 | 204,474 |

*Classified imports during the fiscal years* 1884 *and* 1885.

| Kinds. | 1884. | | 1885. | |
|---|---|---|---|---|
| | Long tons. | Value. | Long tons. | Value. |
| China clay or kaolin | 16,112 | $131,063 | 10,626 | $83,722 |
| All other: | | | | |
| Unwrought | 11,021 | 85,990 | 9,736 | 76,899 |
| Wrought | 2,149 | 16,158 | 3,554 | 29,839 |
| Total | 29,282 | 233,211 | 23,916 | 190,460 |

*Building brick imported and entered for consumption in the United States,* 1868 *to* 1885, *inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| 1868 | ..... | $44,453 | 1877 | 129,970 | $897 |
| 1869 | ..... | 59,359 | 1878 | 25,170 | 166 |
| 1870 | ..... | 46,892 | 1879 | 918,840 | 4,534 |
| 1871 | ..... | 52,997 | 1880 | 349,000 | 1,662 |
| 1872 | ..... | 5,275 | 1881 | 539,600 | 3,002 |
| 1873 | 963,500 | 6,982 | 1882 | 711,150 | 9,168 |
| 1874 | 594,330 | 4,929 | 1883 | 764,700 | 7,958 |
| 1875 | 495,500 | 3,278 | 1884(a) | 531,820 | 9,985 |
| 1876 | 411,550 | 3,147 | 1885 | 1,220,000 | 12,905 |

*a* Classed as "brick other than firebrick."

*Bathbrick and firebrick imported and entered for consumption in the United States,* 1868 *to* 1885, *inclusive.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1868 | $8,763 | 1877 | $43,548 |
| 1869 | 86 | 1878 | 36,679 |
| 1870 | 19,112 | 1879 | 44,681 |
| 1871 | 18,215 | 1880 | 60,589 |
| 1872 | 47,502 | 1881 | 82,581 |
| 1873 | 60,442 | 1882 | 69,575 |
| 1874 | 66,428 | 1883 | 124,948 |
| 1875 | 50,325 | 1884 | (*a*) 103,309 |
| 1876 | 69,063 | 1885 | (*a*) 35,616 |

*a* Firebrick only.

*Firebrick imported since* 1877.

| Fiscal years ending June 30— | Imports. | Fiscal years ending June 30— | Imports. |
|---|---|---|---|
| | *Number.* | | *Number.* |
| 1877 | 303,870 | 1882 | 2,831,033 |
| 1878 | 244,614 | 1883 | 1,250,135 |
| 1879 | 690,954 | 1884 | 1,524,000 |
| 1880 | 1,504,462 | 1885 | 3,401,449 |
| 1881 | 1,968,230 | | |

*Earthenware and china imported and entered for consumption in the United States,* 1867 *to* 1885, *inclusive.*

| Fiscal years ending June 30— | Brown earthen and common stone ware. | China and porcelain not decorated. | China and porcelain decorated. | Other earthen stone, or crockery, glazed, etc. | Total. |
|---|---|---|---|---|---|
| 1867 | $48,618 | $418,493 | $439,824 | $4,280,924 | $5,187,859 |
| 1868 | 47,208 | 309,960 | 403,555 | 3,244,989 | 4,005,712 |
| 1869 | 34,260 | 400,894 | 555,425 | 3,468,970 | 4,459,549 |
| 1870 | 47,457 | 420,442 | 530,805 | 3,461,524 | 4,460,228 |
| 1871 | 96,695 | 391,374 | 571,032 | 3,573,254 | 4,632,355 |
| 1872 | 127,346 | 470,749 | 814,134 | 3,896,664 | 5,308,893 |
| 1873 | 115,253 | 479,617 | 867,206 | 4,289,868 | 5,751,944 |
| 1874 | 70,544 | 397,730 | 676,656 | 3,686,794 | 4,831,724 |
| 1875 | 68,501 | 436,883 | 654,965 | 3,280,867 | 4,441,216 |
| 1876 | 36,744 | 409,539 | 718,156 | 2,948,517 | 4,112,956 |
| 1877 | 30,403 | 326,956 | 668,514 | 2,746,186 | 3,772,059 |
| 1878 | 18,714 | 289,133 | 657,485 | 3,031,393 | 3,996,725 |
| 1879 | 19,868 | 296,591 | 813,850 | 2,914,567 | 4,044,876 |
| 1880 | 31,504 | 334,371 | 1,188,847 | 3,945,666 | 5,500,388 |
| 1881 | 27,586 | 321,259 | 1,621,112 | 4,413,369 | 6,383,326 |
| 1882 | 36,023 | 316,811 | 2,075,708 | 4,438,237 | 6,866,779 |
| 1883 | 43,864 | 368,943 | 2,587,545 | 5,685,709 | 8,686,061 |
| 1884 | 50,172 | 982,499 | 2,664,231 | 666,595 | 4,363,497 |
| 1885 | 44,701 | 823,334 | 2,834,718 | 963,422 | 4,666,175 |

*Value of tiles imported for consumption in the United States,* 1868 *to* 1885, *inclusive.*

| Fiscal years ending June 30— | Encaustic. | Roofing and paving. | Total. |
|---|---|---|---|
| 1868 | $11,423 | ..... | $11,423 |
| 1869 | 7,599 | $1,443 | 9,042 |
| 1870 | 8,549 | 875 | 9,424 |
| 1871 | 4,771 | 884 | 5,655 |
| 1872 | 8,083 | 31,453 | 39,536 |
| 1873 | 18,717 | 51,772 | 70,489 |
| 1874 | 14,193 | 51,010 | 65,204 |
| 1875 | 15,401 | 45,360 | 60,761 |
| 1876 | 15,267 | 29,903 | 45,170 |
| 1877 | 16,787 | 42,143 | 58,930 |
| 1878 | 13,112 | 41,032 | 54,144 |
| 1879 | 17,355 | 31,177 | 48,532 |
| 1880 | 16,896 | 34,063 | 50,959 |
| 1881 | 21,106 | 43,717 | 64,823 |
| 1882 | 27,729 | 46,562 | 74,291 |
| 1883 | 16,459 | 83,777 | 100,236 |
| 1884 | 16,011 | 115,770 | 131,781 |
| 1885 | 10,312 | 99,258 | 109,570 |

*Value of clay exported from the United States, 1865 to 1885, inclusive.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1865 | $29,975 | 1877 | $5,493 |
| 1869 | 5,065 | 1878 | 8,384 |
| 1870 | 2,354 | 1879 | 6,314 |
| 1871 | 10,904 | 1880 | 8,355 |
| 1872 | 5,275 | 1881 | 8,762 |
| 1873 | 4,970 | 1882 | 17,458 |
| 1874 | 8,146 | 1883 | 17,790 |
| 1875 | 13,933 | 1884 | 7,725 |
| 1876 | 4,325 | 1885 | 8,225 |

*Value of brick, etc., of domestic production exported from the United States.*

| Fiscal years ending September 30, until 1842, and June 30 since. | Brick and lime. | Brick, lime, and cement. | Firebrick and firetile. | Brick, other than fire. | Total. |
|---|---|---|---|---|---|
| 1826 | $6,075 | | | | $6,075 |
| 1827 | 3,365 | | | | 3,365 |
| 1828 | 4,573 | | | | 4,578 |
| 1829 | 3,717 | | | | 3,717 |
| 1830 | 2,482 | | | | 2,482 |
| 1831 | 4,412 | | | | 4,412 |
| 1832 | 3,502 | | | | 3,502 |
| 1833 | 3,866 | | | | 3,866 |
| 1834 | 4,294 | | | | 4,294 |
| 1835 | 4,133 | | | | 4,133 |
| 1836 | 6,829 | | | | 6,829 |
| 1837 | 29,626 | | | | 29,626 |
| 1838 | 31,322 | | | | 31,322 |
| 1839 | 16,298 | | | | 16,298 |
| 1840 | 16,949 | | | | 16,949 |
| 1841 | 14,064 | | | | 14,064 |
| 1842 | 5,728 | | | | 5,728 |
| 1843 (nine months) | 3,883 | | | | 3,883 |
| 1844 | 12,833 | | | | 12,833 |
| 1845 | 8,701 | | | | 8,701 |
| 1846 | 12,578 | | | | 12,578 |
| 1847 | 17,623 | | | | 17,623 |
| 1848 | 24,174 | | | | 24,174 |
| 1849 | 8,671 | | | | 8,671 |
| 1850 | 16,348 | | | | 16,348 |
| 1851 | 22,045 | | | | 22,045 |
| 1852 | 13,539 | | | | 13,539 |
| 1853 | 32,625 | | | | 32,625 |
| 1854 | 33,194 | | | | 33,194 |
| 1855 | | $57,393 | | | 57,393 |
| 1856 | | 64,297 | | | 64,297 |
| 1857 | | 68,002 | | | 68,002 |
| 1858 | | 103,821 | | | 103,821 |
| 1859 | | 160,611 | | | 160,611 |
| 1860 | | 154,045 | | | 154,045 |
| 1861 | | 93,292 | | | 93,292 |
| 1862 | | 83,385 | | | 83,385 |
| 1863 | | 99,313 | | | 99,313 |
| 1864 | | 49,106 | | | 49,106 |
| 1865 | | 64,105 | | | 64,105 |
| 1866 | | 146,874 | | | 146,874 |
| 1867 | | 102,324 | | | 102,324 |
| 1868 | | 140,338 | | | 140,338 |
| 1869 | | 83,229 | | | 83,229 |
| 1870 | | | $4,483 | $25,091 | 29,574 |
| 1871 | | | 18,471 | 9,279 | 27,750 |
| 1872 | | | 10,233 | 14,305 | 24,538 |
| 1873 | | | 14,651 | 10,632 | 25,283 |
| 1874 | | | 22,365 | 11,290 | 33,655 |
| 1875 | | | 14,476 | 12,120 | 26,596 |
| 1876 | | | 20,348 | 18,035 | 38,383 |
| 1877 | | | 9,892 | 25,571 | 35,463 |
| 1878 | | | 13,900 | 254,446 | 268,346 |
| 1879 | | | 11,096 | 51,714 | 62,810 |
| 1880 | | | 12,027 | 36,299 | 48,326 |
| 1881 | | | 12,290 | 27,989 | 40,279 |
| 1882 | | | 30,649 | 50,870 | 81,519 |
| 1883 | | | 47,120 | 56,227 | 103,347 |
| 1884 | | | 41,012 | 60,702 | 101,714 |
| 1885 | | | 31,058 | 41,181 | 72,239 |

During the years given there were exported from the port of New York the following number of brick:

*Building brick and firebrick exported from New York.*

| Calendar years. | Building brick. | | Firebrick. | |
|---|---|---|---|---|
| | Number. | Value. | Number. | Value. |
| 1877 | 13,603,475 | $70,629 | 45,000 | $2,185 |
| 1878 | 4,471,980 | 29,457 | 118,994 | 3,148 |
| 1879 | 1,381,775 | 9,371 | 94,976 | 6,867 |
| 1880 | 921,064 | 7,486 | 80,000 | 3,208 |
| 1881 | 971,500 | 8,663 | 181,359 | 8,361 |
| 1882 | 778,000 | 7,026 | 269,810 | 9,843 |
| 1883 | 2,642,625 | 21,737 | 358,616 | 11,039 |
| 1884 | 1,702,850 | 14,148 | 300,100 | 9,042 |
| 1885 | 973,000 | 8,894 | ..... | 12,059 |

*Value of earthenware and stoneware of domestic manufacture exported from the United States.*

| Fiscal years ending September 30, until 1842, and June 30, since. | Value. | Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|---|---|
| 1790 | $1,990 | 1845 | $7,393 | 1866 | $31,616 |
| 1791 | 1,984 | 1846 | 6,521 | 1867 | 29,308 |
| 1826 | 1,958 | 1847 | 4,758 | 1868 | 29,528 |
| 1827 | 6,492 | 1848 | 8,512 | 1869 | 19,213 |
| 1828 | 5,595 | 1849 | 10,632 | 1870 | 42,120 |
| 1829 | 5,592 | 1850 | 15,644 | 1871 | 37,383 |
| 1830 | 2,773 | 1851 | 23,096 | 1872 | 48,941 |
| 1831 | 7,378 | 1852 | 18,310 | 1873 | 53,969 |
| 1832 | 6,333 | 1853 | 53,685 | 1874 | 59,494 |
| 1833 | 12,159 | 1854 | 33,867 | 1875 | 92,253 |
| 1834 | 12,745 | 1855 | 32,119 | 1876 | 73,846 |
| 1835 | 16,427 | 1856 | 66,696 | 1877 | 87,355 |
| 1836 | 13,391 | 1857 | 34,256 | 1878 | 98,035 |
| 1837 | 14,249 | 1858 | 36,783 | 1879 | 80,898 |
| 1838 | 12,019 | 1859 | 47,261 | 1880 | 106,724 |
| 1839 | 11,643 | 1860 | 65,086 | 1881 | 123,177 |
| 1840 | 10,959 | 1861 | 40,524 | 1882 | 180,773 |
| 1841 | 6,737 | 1862 | 32,108 | 1883 | 227,547 |
| 1842 | 7,618 | 1863 | 88,244 | 1884 | 236,247 |
| 1843 (nine months) | 2,907 | 1864 | 67,591 | 1885 | 135,385 |
| 1844 | 4,884 | 1865 | 93,258 | | |

# ABRASIVE MATERIALS.

## BUHRSTONES.

The nearest approach to the hard French buhrstones is a stone occurring on an eminence known as Little Butte, in the Owen's River valley, Inyo county, California. It is hard, brecciated, and very much like the best French stone. The quantity has not been ascertained, but appears to be considerable. Although none of this material has been mined there is little doubt of its value for milling purposes, and it will probably be used in the future. In Ulster county, New York, the so-called Esopus stone has gained a definite footing as a substitute for buhrstone, for millstones for grinding chemicals and other materials except wheat. The production of this stone in 1885 is estimated at a value of $90,000. This, together with a less important production of Cocalico stone in Lancaster county, Pennsylvania, is the only domestic material used for millstones. The total value of all domestic millstones did not exceed $100,000 in 1885. The French millstones are seldom imported as such, but the stone is shipped in comparatively small pieces which are then dressed to a uniform size and carefully fitted together, making one millstone of the ordinary form. There is a continued decrease in the imports, due to the use of the roller process in flour mills.

*Buhrstones and millstones imported and entered for consumption in the United States,* 1868 *to* 1885, *inclusive.*

| Fiscal years ending June 30— | Rough. | Made into millstones. | Total. | Fiscal years ending June 30— | Rough. | Made into millstones. | Total. |
|---|---|---|---|---|---|---|---|
| 1868 | $74,224 | ..... | $74,224 | 1877 | $60,857 | $23,068 | $83,925 |
| 1869 | 57,942 | $2,419 | 60,361 | 1878 | 87,679 | 1,928 | 89,607 |
| 1870 | 58,601 | 2,297 | 60,898 | 1879 | 101,484 | 5,088 | 106,572 |
| 1871 | 35,406 | 3,698 | 39,104 | 1880 | 120,441 | 4,631 | 125,072 |
| 1872 | 69,062 | 5,967 | 75,029 | 1881 | 100,417 | 3,495 | 103,912 |
| 1873 | 60,463 | 8,115 | 68,578 | 1882 | 103,287 | 747 | 104,034 |
| 1874 | 36,540 | 43,170 | 79,710 | 1883 | 73,413 | 272 | 73,685 |
| 1875 | 48,068 | 66,991 | 115,059 | 1884 | 45,837 | 263 | 46,100 |
| 1876 | 37,759 | 46,328 | 84,087 | 1885 | 35,022 | 455 | 35,477 |

## GRINDSTONES.

The most noteworthy change in the grindstone industry during the year 1885 was the consolidation of the large producers in Ohio into the Cleveland Stone Company, which now furnishes nearly all the stone quarried in the State. The value of the total production may be estimated at $500,000, at an average value of $8 to $11 per ton.

*Imports.*—The importation of grindstones is given below.

*Grindstones imported and entered for consumption in the United States, 1868 to 1885, inclusive.*

| Fiscal years ending June 30— | Finished. | | Unfinished or rough. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Long tons.* | | *Long tons.* | | |
| 1868 | ..... | $25, 640 | ..... | $35, 215 | $60, 855 |
| 1869 | ..... | 15, 878 | ..... | 99, 715 | 115, 593 |
| 1870 | ..... | 29, 161 | ..... | 96, 444 | 125, 605 |
| 1871 | 385 | 43, 781 | 3, 957. 15 | 60, 935 | 104, 716 |
| 1872 | 1, 202 | 13, 453 | 10, 774. 80 | 100, 494 | 113, 947 |
| 1873 | 1, 437 | 17, 033 | 8, 376. 84 | 94, 900 | 111, 933 |
| 1874 | 1, 443 | 18, 485 | 7. 721. 44 | 87, 525 | 106, 010 |
| 1875 | 1, 373 | 17, 642 | 7, 656. 17 | 90, 172 | 107. 814 |
| 1876 | 1, 681 | 20, 262 | 6, 079. 34 | 69, 927 | 90, 189 |
| 1877 | 1, 245 | 18, 546 | 4, 979. 75 | 58, 575 | 77, 121 |
| 1878 | 1, 463 | 21, 688 | 3, 669. 41 | 46, 441 | 68, 129 |
| 1879 | 1, 603 | 24, 904 | 4, 584. 16 | 52, 343 | 77, 247 |
| 1880 | 1, 573 | 24, 375 | 4, 578. 59 | 51, 899 | 76, 274 |
| 1881 | 2, 064 | 30, 288 | 5, 044. 71 | 56, 840 | 87, 128 |
| 1882 | 1, 705 | 30, 286 | 5, 945. 61 | 66, 939 | 97, 225 |
| 1883 | 1, 755 | 28, 055 | 6, 945. 63 | 77, 797 | 105, 852 |
| 1884 | ..... | ..... | ..... | ..... | 86, 286 |
| 1885 | ..... | ..... | ..... | ..... | 50, 579 |

## CORUNDUM.

Emery and corundum are found in many localities described in former reports, but all the emery used is imported, principally from Turkey, and the production of corundum is limited to the deposits at Corundum hill, North Carolina, and at Laurel creek, Georgia, as described in the last report. The production has not been reported. The mines are both operated by the Hampden Emery Company, of Chester, Massachusetts.

*Foreign sources.*—An interesting description of the corundum deposits in Asia Minor is contained in the report of Mr. W. E. Stevens, consul at Smyrna, abstracted below:

"Emery stone is found in nearly all parts of Asia Minor, and not unfrequently in the remote and almost inaccessible regions of the interior, where the natural obstacles are too great to offer any inducement to the miner. The principal mines are confined to the districts of Thyra and Aidin, situated to the southward from Smyrna, and not far distant from the line of the Ottoman railway. These are known as: The Tchavus, within one hour's ride from the town of Thyra, owned by Mr. Frederick Charnaud; the Hassan Tchaouslar, owned by Mr. Jackson; the Aladjali Tchiflik and Kourchak, owned by Mrs. Abbot; the Halka or Saladin, owned by Mr. Frederick Charnaud; the Akdere, owned by Mr. Glyka, and the Gurnush Dogh, owned by Mrs. Abbot. There is another mine near Milassa, the stone from which is brought for shipment to a place on the coast called Kuluk, near the gulf of Mendalia. It is either shipped direct from that place to foreign markets or brought to Smyrna in small sailing craft for reshipment.

"When well picked and free from unsound ore and waste, the emery from the Charnaud, Jackson, and Abbot mines is of good and nearly

equal quality. The Glyka or Akdere stone is not as much sought after, while that excavated near Milassa, the larger part of which finds purchasers in the United States, is of inferior quality, the grain being smooth and a great deal of magnetic iron entering into its composition.

"The amount of stone annually shipped from Smyrna to Great Britain, the United States, France, Germany, and Belgium aggregates about 7,000 tons, the relative quantity consumed in each country being in the order named. In the matter of quality, manufacturers in France and Germany are extremely particular; they will have none but thoroughly picked stone, and willingly pay the highest prices to obtain it. In France, especially, Naxos emery, considered to be the best in the world, is used to the almost complete exclusion of all other kinds. In Great Britain, also, purchasers are particular as to quality; but in the United States, especially within a few years past, importers have encouraged the shipment of inferior or uncleaned stone, because of its lower price. Good clean lump emery stone can be contracted for here on board ships at $19.50 to $20.70 per ton of 2,240 pounds, and the same quality, but in smaller pieces, say 1¼ to 1½ inches, at $3.65 per ton less than these figures.

"The rates of freight for emery stone shipped in bulk by steamers to the ports of the north of France, the Netherlands, and Germany are from $3.90 to $4.38 per ton; to London, $2.33 to $2.92; to Liverpool, $3.90 to $4.87; to New York or Boston the freight is $1.22 to $2.44 per ton. Sailing ships with cargoes of licorice root require ballast, and so the stone is readily taken at almost a nominal freight.

"The customs duty is only 16 cents per ton, but as 'backsheesh' is indispensable in all dealings with Turkish customs officials, this charge is equivalent to 25 cents. The quay dues are 4 cents per ton. The Turkish Government levies a duty or royalty of $3.21 on every ton of emery shipped. In addition, the grantee must pay a tax of 2½ cents per acre on the area of land ceded him by his firman.

"The mines are opened by wells and galleries, and the stone is obtained in most instances by blasting, gunpowder and dynamite being freely used to extract it from between blocks of marble or masses of granite. The overseers and principal workmen at the mines are Italians, who are paid 82 cents per diem; the native workmen are paid only about half as much. In some cases the mining is attended with difficulty and expense. At the Jackson mine, for example, the stone is procured from a great depth, and is covered with water, necessitating the employment of a steam pump. At Kourchak, not even blasting is required, the emery being dug up from the red argillaceous earth wherewith it is mixed. The coating of the stone varies with the color of the earth or rock in which it is found—from red to brown, gray, or white; and, as a rule, no correct judgment of the quality can be formed from its outward appearance. But the grain must be closely examined. This should be hard, bright, and coarse, resembling gunpowder, and varying in hue from reddish black to dark bluish gray. The grain must be tested before one

can certainly know its abrading power, which it has been ascertained does not solely depend upon the amount of alumina it contains, but also upon the particular way in which the particles have been placed by nature. In the Tchaous concession, near Thyra, a great deal of the emery is not mined, owing to the presence of mica in the grain.

"The emery is picked daily at the mines as fast as it is extracted, in some instances not one-half the quantity being selected. It is then conveyed by camels to the nearest railway station and from thence to Smyrna, where it is generally picked again previous to shipment. When the mines are situated on heights inaccessible to camels, the ore is brought down to the plain by donkeys. If the pieces are too large to be carried by camels, they are brought to the station in carts drawn by buffaloes. But these very large pieces are broken at the mines with sledge hammers, after having been subjected to the action of fire to facilitate their breaking. The railway rates are rather high; from Thyra to Smyrna, for instance, a distance of 60 miles, the charge is equal to $3.36 per ton; and from Cosbonnar, the railway station from which the greater part of the ore is brought, and distant 41 miles from Smyrna, the rate is $2.20.

"The mines are worked upon the strength of concessions, termed 'firmans,' granted by the Imperial Government for a period usually of ninety-nine years, or in cases where the emery has been found on 'nacouf' property, *i. e.*, belonging to the Turkish religious institutions, by special permit of the department at Constantinople which administers the 'nacouf' estates, and exacts payment to them of so much per kintol. A 'firman,' or concession, during the period it is in force, can be sold, transferred, and transmitted by inheritance, like other property in Turkey, provided due notice be given to the department of mines at Constantinople, and authorization formally obtained. The obtainment of a 'firman' is at all times attended with difficulties, loss of time, and expense. According to by-laws on mines, the formalities to be accomplished appear very simple and the cost of the concession reasonable, but an applicant soon finds all this to be a delusion. Its obtainment is at present still harder and more tedious to Europeans, owing to the reigning Sultan being averse to granting concessions to subjects of foreign Governments, although the grantee would always be amenable to Turkish law in all matters having reference to his concession. The difficulty can, however, be avoided by making the demand in the name of an Ottoman subject, and it would facilitate things all the more if he be, besides, a Mussulman. At all events, it is almost absolutely necessary that the demand of a foreigner be made at least jointly with an Ottoman subject, so that the latter's name may be also inserted in the firman presented for imperial sanction.

"*Naxos emery.*—The emery in the island of Naxos is farmed or let out by lease to firms or private individuals by the Greek Government for periods of twelve consecutive years. Sealed tenders are sent in by

persons wishing to compete, and the contract is allotted to the highest bidder. The party who obtains the monopoly for twelve years has to deposit forthwith in the National Bank of Greece $19,300, to remain there as a guarantee for the fulfillment of his engagements during the whole period. He has to bind himself to take a minimum of 1,650 tons annually, at $42.50 per ton put free on board at Naxos, for the emery just as it is excavated, without selection.

"The lessee is free to take double or triple the quantity if he wishes but is obliged to take at least 1,650 tons. Formerly the price was higher and the minimum quantity fixed larger, but the contractors lost money. The lowest price at which Naxos emery could then be had from them was $48.70 per ton put free on board at Syra.

"The greater part of the emery has to be brought to the neighboring island of Syra, in sailing vessels, at the contractor's expense, where it is reshipped. Steamers or large vessels cannot load at Naxos, except during the fine season, owing to the absence of shelter, which renders the operation dangerous The contract of the present lessees, a Greek firm of Syra, has still about seven years to run. They will not sell to any one free on board, as their predecessors did, but have agencies and stocks in the principal markets of Europe and the United States."

*Emery imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Grains. | | Ore or rock. | | Pulverized or ground. | | Powdered. | Total. |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | | |
| | *Pounds.* | | *Tons.* | | *Pounds.* | | | |
| 1867 | ..... | ..... | 428 | $14,373 | 924,431 | $38,131 | ..... | $52,504 |
| 1868 | ..... | ..... | 85 | 4,531 | 834,286 | 33,549 | ..... | 38,080 |
| 1869 | ..... | ..... | 964 | 35,205 | 924,161 | 42,711 | ..... | 77,916 |
| 1870 | ..... | ..... | 742 | 25,335 | 644,680 | 29,531 | ..... | 54,866 |
| 1871 | ..... | ..... | 615 | 15,870 | 613,624 | 28,941 | ..... | 44,811 |
| 1872 | ..... | ..... | 1,641 | 41,321 | 804,977 | 36,103 | ..... | 77,424 |
| 1873 | 610,117 | $29,706 | 755 | 26,065 | 343,828 | 15,041 | 107 | 70,919 |
| 1874 | 331,580 | 16,216 | 1,281 | 43,886 | 69,890 | 2,167 | 97 | 62,366 |
| 1875 | 487,725 | 23,345 | 961 | 31,972 | 85,853 | 2,990 | 20 | 58,327 |
| 1876 | 385,246 | 18,999 | 1,395 | 40,027 | 77,382 | 2,533 | 94 | 61,653 |
| 1877 | 343,697 | 16,615 | 852 | 21,964 | 96,351 | 3,603 | ..... | 42,182 |
| 1878 | 334,291 | 16,359 | 1,475 | 38,454 | 65,068 | 1,754 | 34 | 56,601 |
| 1879 | 496,633 | 24,456 | 2,478 | 58,065 | 133,556 | 4,985 | ..... | 87,506 |
| 1880 | 411,340 | 20,066 | 3,400 | 76,481 | 223,855 | 9,202 | 145 | 105,894 |
| 1881 | 454,790 | 22,101 | 2,884 | 67,781 | 177,174 | 7,497 | 53 | 97,432 |
| 1882 | 520,214 | 25,314 | 2,765 | 69,432 | 117,008 | 3,708 | 241 | 98,695 |
| 1883 | 474,105 | 22,767 | 2,447 | 59,282 | 93,010 | 3,172 | 269 | 85,490 |
| 1884 | 143,267 | 5,802 | 4,145 | 121,719 | 513,161 | 21,181 | (a) | ..... |
| 1885 | 228,329 | 9,886 | 2,445 | 55,368 | 194,314 | 8,789 | (a) | ..... |

*a* Not specified.

*Exports of manufactured emery.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1878 | $1,608 | 1882 | $813 |
| 1879 | 1,265 | 1883 | 1,857 |
| 1880 | 1,312 | 1884 | 3,565 |
| 1881 | 1,242 | 1885 | 19,232 |

## INFUSORIAL EARTH.

The deposit of infusorial earth, locally known as "tripoli," on the Patuxent river, near Dunkirk, in Calvert county, Maryland, was referred to in the last report. Operations for mining this deposit upon an extended scale were begun in September, 1885, but the output was not over 250 tons before the close of navigation ended shipments for the year. It was shipped principally to New York for use as a nonconductor and also as a polishing powder. There is no record of work on the deposits near Richmond, Virginia, nor on those near Virginia City, Nevada, during 1885.

## PUMICE STONE.

There was little change in the slight production of pumice stone near Lake Merced, a few miles from San Francisco, California. The production did not exceed 70 tons. The greater part of the pumice stone used for polishing wood surfaces, etc., is imported, according to the following table:

*Pumice stone imported and entered for consumption in the United States, 1871 to 1885, inclusive.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1871 | $6,448 | 1879 | $12,892 |
| 1872 | 12,796 | 1880 | 15,520 |
| 1873 | 9,264 | 1881 | 19,052 |
| 1874 | 22,899 | 1882 | 29,370 |
| 1875 | 8,726 | 1883 | 50,634 |
| 1876 | 9,122 | 1884 | 26,667 |
| 1877 | 11,556 | 1885 | 14,147 |
| 1878 | 12,343 | | |

## NOVACULITE.

By George M. Turner.

The word novaculite (from *novacula*, a razor), according to its present use, is applied to a class of siliceous rocks which are valuable because of their grit or sharpening qualities as whetstones. This peculiar sharpening quality is due in some cases to crystalline silica, in others, according to a German writer, to small crystals of garnet or rutile.

*Occurrence.*—The principal source of the novaculite produced in this country at present, is the region embraced by Hot Spring and Garland counties, Arkansas. It is also quarried in Grafton county, New Hampshire, and in Orange county, Indiana. Quarries are reported in Onondaga county, New York, but no reliable information concerning them has been obtained.

*Arkansas.*—Although the main source of the Arkansas novaculite is in Hot Spring and Garland counties, a few deposits are found in Mont-

gomery and Saline counties. The best oilstone comes almost entirely from Garland county. A tract of land about 50 miles long by 20 miles wide will include the area from which the oilstone is taken. Two varieties of novaculite are quarried here, and are commercially known under the names of "Washita" oilstone and "Arkansas" oilstone. The former is used by carpenters and wood workmen in general, while the latter is particularly adapted for the use of watchmakers, dentists, and surgeons.

The "Arkansas" stone is a very compact, bluish white, semi-translucent rock of uniform color and structure. The best "Washita" is less compact than the "Arkansas" stone, pure white and opaque. They are both composed of nearly pure, very fine-grained quartz, and differ from each other only in that the grains of quartz are finer and the spaces between them much smaller in the "Arkansas" than in the "Washita" stone. Both kinds are found in narrow leads from 5 to 15 feet wide, running northeast and southwest on the north side of the mountains of the Ozark range, and lying between walls of a very similar character. Some of these leads are less than a mile long, while others are several miles in length. The quality of the stone in the same lead often varies considerably as the quarrying progresses. Perfect whetstones of even grit, uniform in crystallization, and free from all impurities are found in only a few places, which are nearly always less than 100 feet in length, and are called pockets. The novaculite has been very much cracked and broken up by natural forces. The workable rock is often rendered worthless by the presence of vitreous lumps of quartz, which sometimes appear in the midst of the best producing rock, so that nearly one half of the rock taken out of the quarries goes into the waste pile. The hot springs occurring in the immediate neighborhood of the oilstone region probably play an important part in the deposition of silica in the form of novaculite. The structure of the Arkansas rock, from its appearance under the microscope, is similar to that of marble. The crystals in forming have so run into each other as to prevent the natural crystalline faces from appearing, but have left minute cavities between the quartz grains. Up to the present time no thorough investigation has been made as to how the silica came into solution and was deposited as novaculite. There are also no data which lead us to suspect that it was deposited in a different manner from the silica of the hot-spring region of the Yellowstone Park, which region has been carefully studied and described by Hayden in his report on the "Geological Survey of the Territories."

*New Hampshire.*—Although whetstone schists occur, according to Hitchcock's "Geology of New Hampshire," at Piermont, Lisbon, and Littleton, in Grafton county; Tamworth, Carroll county; and Connecticut Lake, Coos county, only the deposits in Littleton and Lisbon are worked. The novaculite taken from these quarries is known in the

market as "chocolate" stone. It is very different, both in composition and structure, from the novaculite found in Arkansas. It is an argillitic mica schist of a dark gray color. Under the microscope were discernible: silica in the form of small quartz crystals; a substance which appeared black and could not be recognized by the microscope alone; minute crystals of garnet scattered through the whole mass; small plates of mica; and a few crystals of rutile. All the minute quartz crystals have their corresponding axes running parallel to each other. This arrangement, together with the mica present, gives to the rock its schistose structure and characteristic appearance. The small garnets present probably give to the rock its peculiar power for use as a whetstone. On a partial chemical analysis of the rock the substance which appeared black under the microscope proved to be a compound of manganese (probably one of the higher oxides) together with a small amount of iron.

*Indiana.*—Owing to the reticence of the firms with whom correspondence was undertaken concerning the so called "Hindostan" stone of Indiana, no reliable statements could be obtained from them. The only information upon which dependence can be placed is the account given of this whetstone in the Geological Report of Indiana for 1875, by E. T. Cox, the State geologist. The quarries are located near French Lick, Orange county. The rock is described as being of schistose structure, evenly stratified, and capable of being split with great ease. A large number of fossils of great beauty and size have been found in this rock; among them are beautifully preserved leaves and what appear to be crustacean tracks. There are also some fine dendrites. The stone quarried is of even texture and fine grained. The two forms under which it is placed on the market are the "Hindostan," which is white in color, and a buff variety known as the "Orange" stone. The novaculite of this locality, as determined by the fossils in the rocks, is said to be of the same geological horizon as the novaculite of Arkansas.

*Production and prices.*—About 500,000 pounds of the "Washita" and 30,000 pounds of the "Arkansas" stone in the rough are quarried and sold annually. The sound Washita is shaped into blocks of from 100 to 2,500 pounds, and shipped to the various whetstone factories throughout the country. The "Arkansas" stone is found in small pieces—sometimes as small as 2 pounds—and is packed in barrels for shipment. The stones are cut by means of saws. This method of preparing the stone for market is very slow, and hence the cost of the finished stone becomes greatly increased over that of the uncut. A gang of saws which will cut from 12 to 15 inches a day in marble will cut only about 4 inches of Washita and three-quarters of an inch of "Arkansas" stone. The rough Washita sells at the quarry at from 1 to 3 cents per pound, and the uncut "Arkansas" from 4 to 6 cents per pound. The latest price list of three combined firms (J. J. Sutton, of Hot Springs, Arkansas;

George Chase, of New York; and F. E. Dishman, of New Albany, Indiana) is as follows for the Washita stone:

*Price list of Washita stone in* 1885.

| Grades. | Cents per pound. |
|---|---|
| Washita stone; | |
| No. 1 (extra) | 25 |
| No. 1 | 20 |
| No. 2 | 16 |
| Washita slips: | |
| No. 1 (extra) | 50 |
| No. 1 | 40 |

No. 1 is taken as their standard stone. "Arkansas" stone sells at from $1.25 to $2 per pound, according to the size of the piece. The great difference in price between crude and finished stone is due to the cost of preparing it for market.

The quarry of the "chocolate" stone has been, until quite recently, developed mainly for local use, so that only about 15,000 pounds of the stone are now annually taken from the quarry. The method of preparing this novaculite for market is practically the same as in case of the Washita and "Arkansas" stones. The stone is cut with iron blades by the use of sand and then finished on iron wheels with sand. This stone, not being as hard as the Washita and "Arkansas" stones, the cost of manufacture is much less. The estimated cost of preparing the "chocolate" stone for market is about 10 cents per pound.

*Use.*—Until quite recently the use of novaculite was confined to the sharpening of edged tools. Of late it has come into use for grinding, reducing, and finishing. It has invaded the limits of the grindstone, emery, rottenstone, tripoli powder, and has reached almost to rouge. It is cut and dressed in many different forms for varying purposes. In any hardware store it may be found in various shapes under the name of slips, adapted for sharpening tools of all forms. In dentists' supply stores it may be found in a number of cylindrical, circular, and ovoid forms, sufficiently small to be used between the teeth in dental work. In the manufacture and finishing of metals, novaculite is also used for truing turned and planed surfaces of iron and brass, slowly grinding down the imperfections left by the finish file and corundum wheel. Some varieties have also been used to a certain extent in the powdered form in place of emery.

# PRECIOUS STONES.

By George F. Kunz.

In addition to the report on precious stones in the last volume, where the subject was treated in detail, the following pages are intended to show the progress in this field during 1885.

Work was carried on at the Mount Mica tourmaline locality, Paris, Maine, during the months of June, July, and August of the present year, but no crystals of any value were found, all efforts being directed to the removal of the rock above the tourmaline layer. Messrs. N. H. Perry and E. M. Bailey also worked at the Rumford locality for a few weeks, some good specimens were obtained.

For two months during the summer of 1885 work was carried on by the Emerald and Hiddenite Mining Company, at Stony Point, North Carolina, under the direction of the superintendent, Mr. W. E. Hidden, and with flattering success. A remarkably large pocket, containing fine crystals of muscovite with brilliant crystals of rutile implanted on them, was found and sold as cabinet specimens for $750. While they were working in the soil overlying the rock nine crystals of emerald were found all doubly terminated and measuring from 25 millimeters (1 inch) to 77 millimeters ($3\frac{1}{8}$ inches) in length and 42 millimeters ($1\frac{3}{8}$ inches) in width. This latter crystal is very perfect as a specimen; it is of a fine light green color and doubly terminated. It weighs $8\frac{3}{4}$ ounces, only one fourth ounce less than the famous Duke of Devonshire emerald crystal, and is held by the company at $1,500 as a cabinet specimen, the nine crystals together being held at $3,000.

Another of these crystals, which is doubly terminated, measures 63 millimeters ($2\frac{1}{2}$ inches) by 23 millimeters ($\frac{11}{12}$ inch), and is filled with large rhombohedral cavities, formerly containing dolomite. As mineral specimens these crystals are quite unique. The only gem which has been cut from this find was found in a pocket at a depth of over 43 feet. In color it is a pleasing light green, and weighs $4\frac{23}{32}$ carats. No crystal of finer color has yet been found in the United States, and this gem is held by the company at $200.

During the recent mining the largest fine crystal of lithia emerald ever found was also brought to light. It measures 68 millimeters ($2\frac{3}{4}$ inches) by 14 millimeters ($\frac{3}{5}$ inch) by 8 millimeters ($\frac{1}{3}$ inch). One end is of very fine color, and would afford the largest gem yet found of this mineral, weighing perhaps $5\frac{1}{2}$ carats. With this was a number of

superior crystals and some ounces of common pieces of the same mineral. The owners estimate the worth of this entire yield of hiddenite at about $2,500.

A quantity of quartz filled with white byssolite or asbestiform mineral, which makes very attractive specimens, is valued at $250. On the whole this is an encouraging find for this line of minerals.

The locality for emeralds referred to in the last volume of "Mineral Resources of the United States," page 739, is only a duplication of the locality described as J. O. Lackey's in the *American Journal of Science*, III. series, Vol. XXVII., page 153.

Hiddenite has also been found during the past year in working the property known as the Morton tract, formerly known as Smeaton's and Lyon's properties ("Mineral Resources of the United States, 1883 and 1884," page 739).

Among the fictitous reports of the finding of gems may be mentioned that of the finding of three diamonds and about a dozen topazes in the gravel along the Sangamon river, near Springfield, Illinois.

What is perhaps the finest collection of rough diamond crystals in existence was exhibited during the past year by Messrs. Tiffany & Co. in New York. It consisted of 904 crystals, weighing in the aggregate 1,876½ carats, and was valued at $30,000. This has since been returned to Europe. For description see "Report of the American Association for the Advancement of Science, 1885," page 250.

At the meeting of the British Association, held at Birmingham, September, 1886, Prof. H. Carvil Lewis read a paper on "Diamond-bearing Peridotite," in which he said he had found in Kentucky, peridotite similar to that which occurs in the Kimberley mine, and was convinced that a search would reveal the presence of diamonds in that State. Now, the diamonds in the South African deposits are accompanied by carbonaceous shale which surrounds the mine, and is also scattered through the so called "blue stuff" in sizes varying from microscopic specks to large detached masses, and forming a sort of breccia, so to speak. The theory of the volcanic origin of these pipes was first advanced by Dr. E. Cohen. In the opinion of the writer the peridotite alone is not sufficient to account for the diamonds, but rather its mixture with the shale. Unless this carbonaceous shale is present under similar conditions in Kentucky the outlook for diamonds is not encouraging. In further confirmation of this view may be mentioned Prof. H. E. Roscoe's discovery of an aromatic hydrocarbon on treating diamond earth with hot water. This hydrocarbon, which he separated by digesting the earth with ether and allowing it to evaporate, was crystalline, strongly aromatic, volatile, burned with a smoky flame, and melted at 50° C. It was unfortunate that the quantity of the substance obtained was too small to admit of a full investigation. (Proceedings of Manchester Literary and Philosophical Society, October 17, 1884, page 5.)

A recent London periodical made the statement that any one who found the sapphire and ruby in its original matrix would soon be called the "King of Rubies," and that his fortune would be assured. This recalls the fact that Col. C. W. Jencks, of Boston, was the original finder of the true corundum gems *in situ* at the Jencks mine at Franklin, North Carolina; that he obtained from this locality nearly all of the fine crystals in the best American collections. One of the most interesting of his finds is a piece of a blue crystal with a white band running across it, and a place in the center where a nodule had dropped out.(*a*) This piece was cut and placed back in its original place, and the white band can be seen running across both gem and rock. Nearly all of the fine gems from this locality mentioned in the two previous reports were also brought to light by his mining. The gems were found here in their original matrix, but they were of such rare occurrence that it was not feasible to mine for them more thoroughly. The corundum mining has proved profitable, however, and is still carried on by Dr. Lucas.

A number of beryls of fine blue color, resembling the Mourne mountain beryls, have been found near Mount Antero, in the Arkansas valley, Chaffee county, Colorado. One of these was 4 inches long and three-eighths of an inch across with cutting material in it. The other crystals measured from 1 inch to $1\frac{1}{4}$ inches in length and one fifth to one third inch in width.

The large beryl mentioned in "Mineral Resources" for 1883 and 1884, has afforded the finest aquamarine of American origin known. It weighs $133\frac{3}{4}$ carats and measures 35 by 35 by 20 millimeters. It is a brilliant cut gem and with the exception of a few internal hair-like striations it is absolutely perfect. The color is a deep bluish green, equal to that of gems from any known locality.

Mr. George F. Breed, manager of the Valencia Mica Company, has cut from white beryls nearly 100 aquamarines, ranging from one half to 4 carats in weight, and of a light blue color, which were found in their mica mine at North Groton, Grafton county, New Hampshire.

A number of very fine, deep golden yellow, blue, and green beryls, equaling any ever found, were shown to the writer by Mr. M. W. Barse, of Olean, New York, taken from his mica mine between New Milford and Litchfield, Litchfield county, Connecticut. Some fine blood-red garnets from here were cut into gems. Some other parties have sold stones from the same locality which are possibly new gems nearly as hard as the sapphire, and said to come from South America. Since these statements gained currency abroad a correction was deemed necessary. They are undoubtedly American beryls from the above locality.

The finest large phenacite crystal ever found in the United States is the one in the possession of Mr. Whitman Cross. It was found at Crystal Park, Colorado, weighs 59 pennyweights 6 grains, and measures 46.5

*a* London *Jeweler and Metalworker*, August, 1886.

millimeters in length and 32 millimeters in thickness. Occasional transparent spots are noticeable. Full descriptions of phenacite from Crystal Park and Florissant, Colorado, and of topaz from near Pike's Peak and Devil's Head mountain, Colorado, and also of that found in nevadite at Chaltk mountain, in the same State, are given by Messrs. Cross and W. F. Hillebrand in "Bulletin No. 20 of the United States Geological Survey, Washington, 1885." Phenacite from the Florissant locality was also described by W. E. Hidden in the *American Journal of Science*, III. series, Vol. XXIX., page 249. These crystals at Florissant were first found by Mr. J. G. Heistand, of Manitou, Colorado.

Thousands of garnet crystals found at Ruby mountain, near Salides, Chaffee county, Colorado, have been made into paper weights and sold to tourists. Those weighing a few ounces sell for about 10 cents each, and one weighing 14 pounds was sold. Regular printed lists running up to 4 pounds weight are sent out with scale of prices attached. They have a chlorite coating which can easily be removed.

The finding in the heart of New York City, in Thirty-fifth street, between Broadway and Seventh avenue, of a garnet crystal as perfect as any ever found on this continent, and weighing 9 pounds 10 ounces, is of peculiar interest.

A full account of the wood jasper deposit of Arizona was published in the *Popular Science Monthly* for January, 1886, and in the *Scientific American* for January. Several thousands of dollars' worth of this material has been cut into paper weights, charms, and other articles of jewelry, or polished on one side for cabinet specimens. At the present time numbers of these articles are being cut and sold to tourists along the line of the Atchison, Topeka and Santa Fé railroad. The base of the *World*-fund memorial to be presented to the eminent sculptor, M. Bartholdi, was made out of pieces of this stone.

The compact quartzite of Sioux Falls, Dakota, has been quarried and polished for ornamental purposes. It is known and sold as "Sioux Falls jasper," and is really the stone referred to by Longfellow in his "Hiawatha" as being used for arrow heads. This stone is susceptible of a very high polish and is found in a variety of pleasing tints, such as chocolate, brownish red, brick red, and yellowish. The polished material has been sold to the amount of $15,000 during the last two years, and polishing works run by water power have been erected, and so ingeniously are they contrived that pillars, pilasters, mantels, and table tops can be made here as cheaply as anywhere. The pilasters of the German American Bank in Saint Paul, Minnesota, and the columns in the doorway of the Chamber of Commerce building in the same city are of this beautiful jasper. It is likely to become one of our choicest ornamental stones, especially effective in combination with the Minnesota red granite. Its great tensile strength, its high, almost mirror-like polish, the fact that though so highly polished, the stone is not slippery, the large pieces that can be quarried out, and the pleasing variety of

colors, all combine to render this one of the most desirable building stones. Polishing mills have been built of sufficient capacity to polish $100,000 worth per annum, and in view of the unequaled facility with which it can be prepared for use, it could be made into tablets, blocks, columns, and tiles with advantage, and employed for fine interior and monumental work or in the more artistic branches of stone work. Some good results have been obtained with the sand blast on polished surfaces.

A remarkable mass of rock crystal was recently sent to Messrs. Tiffany & Co. from a place near Cave City, Virginia. Although it weighed 51 pounds this mass was only a fragment of the original crystal, which weighed 300 pounds, but was unfortunately broken in pieces by the ignorant mountain girl who found it. Still this fragment will furnish slabs 8 inches square and ½ to 1 inch thick. The original crystal, if it had remained intact, would have furnished a crystal ball perhaps 4½ to 5 inches in diameter and almost perfect. It is likely that further working in this locality would bring some fine material to light. (Trans. American Assoc. Adv. Science, 1886.)

Mr. F. C. Yeomans, of Washougal, Washington Territory, has found quite a variety of fine agates and moss agates at the above locality.

The menaccanite from Cumberland, Rhode Island, is often spotted with white quartz. Mr. E. Passmore, of Hope, Rhode Island, has cut it into oval stones several inches long, which admitted of a fine polish. This quality, coupled with its hardness, makes it a desirable ornamental gem stone.

It may be worthy of mention that the writer found pieces of peridot, of sufficient transparency to afford *gems* one-fifth inch long, in the largest mass of the Glorieta mountain, Santa Fé county, New Mexico, meteorite. (*American Journal of Science.*, III. series, Vol. XXXII., October, 1886.)

The turquois pseudomorph after apatite from Taylor's ranch on the northeast side of the Chowchilla river, California, has been described by G. E. Moore and V.von Zepharooich (*Zeitsch. fur Kryst. u. Min.*, Vol. X., p. 240). The turquois from Los Cerillos, New Mexico, has been fully analyzed and described by Prof. F. W. Clarke and Mr. J. S. Diller in the *American Journal of Science*, III. series, Vol. XXXII., page 211, September, 1886. Large quantities of this material have been sold, both as specimens and gems. Unfortunately many of those of finest color were found to have been artifically stained. A full series of this mineral has been presented to the National Museum.

Malachite in large masses has been found at the Copper Queen mine at Bisbee, Arizona. One of these masses weighed 15 pounds and others were nearly as large. All were of good enough quality and large enough for tablet tops.

Mr. F. F. Chisolm states that specimens of what appears to be amber were found in one of the Union Pacific coal mines in Wyoming

in 1885, but the tests are not yet completed, so that its genuineness cannot be asserted. He says: "The material which was brought to Denver was hard, highly electric, and of a good clear yellow color. Its fusion point was a little low, and the odor of a burning fragment slightly resembled that of burning india rubber. In places the substance occurs 2 inches thick. The exact place of its occurrence has not yet been ascertained." A few of the choice minerals and gems in the collection of Mr. Clarence S. Bement were well described by Prof. Gerhard vom Rath in the *Jewelers' Circular*, Vol. XVI., No. 12, January, 1886.

Mr. William H. Andrews, of Gouverneur, Saint Lawrence county, New York, has a remarkable collection of 2,200 specimens of polished marbles, serpentines, jaspers, agates, and other ornamental stones, principally from Saint Lawrence, Jefferson, and adjacent counties. A variety of other minerals are also to be found in this collection, which, though the polishing is mainly the work of Mr. Andrews himself, is one of the most complete series of the kind in the United States.

Popular articles have appeared during the year on North Carolina gem stones by Mr. C. D. Smith; on diamonds by William Wareing Habersham (both of these appeared in *Dixie*, published in Atlanta, Georgia, January, 1886), and an article on how hiddenite was formed, by Mr. W. E. Hidden, in *Dixie*, December, 1885.

The National Museum collection of gems, formed by Prof. F. W. Clarke, is now one of the most complete for species in the United States, and as many of the gems are of more than average merit and all can have access to them, this is one of the best opportunities afforded the student in this country. The *Popular Science Monthly* for April, 1886, contains a description of this collection, which, with additions to date, will also appear in the bulletin of the National Museum.

An immense number of small collections of minerals have been sold during the past year, usually consisting of specimens not over $\frac{1}{4}$ to 2 inches square of a series of some ten to fifty of the principal minerals, or the minerals of a section, or of polished and ornamental stones; sets of fifty; selling for from $1 to $5, are arrayed in cases or pasted to boards. The name which is given to them is generally copyrighted. Thousands of these collections are sold annually.

### PRODUCTION OF PRECIOUS STONES IN THE UNITED STATES.

While it is impossible to obtain exact returns of the values of the precious stones found in the United States, it is believed that the estimates given in the following table represent, roughly, the total values and the proportionate values of the several mineralogical species. Gold quartz, the value of which should be more properly perhaps included under the head of gold mining, is added at the close of the list.

*Estimated production of precious stones in the United States in* 1883, 1884, *and* 1885.

| Species. | 1883. | | | 1884. | | | 1885. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Value of stones found and sold as specimens and curiosities, occasionally polished to beautify or show structure. | Value of stones found and sold to be cut into gems. | Total. | Value of stones found and sold as specimens and curiosities, occasionally polished to beautify or show structure. | Value of stones found and sold to be cut into gems. | Total. | Value of stones found and sold as specimens and curiosities, occasionally polished to beautify or show structure. | Value of stones found and sold to be cut into gems. | Total. |
| Diamond | ..... | ..... | ..... | ..... | $800 | $800 | ..... | ..... | ..... |
| Sapphire gems | $200 | $2,000 | $2,200 | $250 | 1,500 | 1,750 | ..... | $500 | $500 |
| Chrysoberyl | 100 | ..... | 100 | 25 | ..... | 25 | ..... | ..... | ..... |
| Topaz | 1,000 | ..... | 1,000 | 200 | 300 | 500 | $1,000 | 250 | 1,250 |
| Beryl | 200 | 300 | 500 | 300 | 400 | 700 | 250 | 500 | 750 |
| Emerald | 500 | ..... | 500 | ..... | ..... | ..... | 3,000 | 200 | 3,200 |
| Hiddenite | 100 | 500 | 600 | ..... | ..... | ..... | 500 | 2,000 | 2,500 |
| Tourmaline | ..... | ..... | ..... | 1,500 | 500 | 2,000 | 500 | 100 | 600 |
| Smoky quartz | 2,500 | 7,500 | 10,000 | 2,000 | 10,000 | 12,000 | 2,000 | 5,000 | 7,000 |
| Quartz | 10,000 | 1,500 | 11,500 | 10,000 | 1,500 | 11,500 | 10,000 | 1,500 | 11,500 |
| Silicified wood | 5,000 | ..... | 5,000 | 10,000 | 500 | 10,500 | 5,000 | 1,500 | 6,500 |
| Garnet | 1,000 | 5,000 | 6,000 | 1,000 | 3,000 | 4,000 | 200 | 2,500 | 2,700 |
| Anthracite | ..... | 2,500 | 2,500 | ..... | 2,500 | 2,500 | ..... | 2,500 | 2,500 |
| Pyrite | 1,500 | 500 | 2,000 | 2,000 | 1,000 | 3,000 | 1,500 | 500 | 2,000 |
| Amazonstone | 3,500 | 250 | 3,750 | 2,500 | 250 | 2,750 | 2,500 | 250 | 2,750 |
| Catlinite (pipestone) | 10,000 | ..... | 10,000 | 10,000 | ..... | 10,000 | 10,000 | ..... | 10,000 |
| Arrow points | 1,000 | ..... | 1,000 | 1,000 | ..... | 1,000 | ..... | 2,500 | 2,500 |
| Trilobites | 500 | ..... | 500 | 500 | ..... | 500 | ..... | 1,000 | 1,000 |
| Sagenitic rutile | 500 | 500 | 1,000 | 500 | 500 | 1,000 | ..... | 250 | 250 |
| Hornblende in quartz | 500 | 100 | 600 | 500 | 100 | 600 | ..... | 300 | 300 |
| Peridot | 50 | 250 | 300 | 50 | 100 | 150 | ..... | 50 | 50 |
| Thompsonite | 250 | 500 | 750 | 250 | 500 | 750 | 250 | 500 | 750 |
| Diopside | 200 | 100 | 300 | ..... | ..... | ..... | 100 | ..... | 100 |
| Agate | 1,000 | 500 | 1,500 | 4,000 | 500 | 4,500 | 1,000 | 1,000 | 2,000 |
| Chlorastrolite | 500 | 1,000 | 1,500 | 500 | 1,000 | 1,500 | ..... | ..... | ..... |
| Turquois | 1,500 | 500 | 2,000 | 1,500 | 500 | 2,000 | 1,500 | 2,000 | 3,500 |
| Moss agate | 1,000 | 2,000 | 3,000 | 1,000 | 2,000 | 3,000 | 500 | 2,000 | 2,500 |
| Amethyst | 2,000 | 250 | 2,250 | 2,000 | 250 | 2,250 | 2,000 | 100 | 2,100 |
| Jasper | 2,000 | 500 | 2,500 | 2,000 | 500 | 2,500 | ..... | ..... | ..... |
| Sunstone | 250 | 200 | 450 | 250 | 200 | 450 | 250 | 100 | 350 |
| Fossil coral | 500 | 250 | 750 | 500 | 250 | 750 | ..... | ..... | ..... |
| Rutile | ..... | ..... | ..... | ..... | ..... | ..... | 750 | ..... | 750 |
| Total | 47,350 | 26,700 | 74,050 | 54,325 | 28,650 | 82,975 | 42,800 | 27,100 | 69,900 |
| Gold quartz | 40,000 | 75,000 | 115,000 | 40,000 | 100,000 | 140,000 | 40,000 | 100,000 | 140,000 |

By recalculating from the value of the diamond carat as used in different countries the equivalents in the metric system, the weights in the four places of decimals, according to Mr. Louis D'A. Jackson, in his "Modern Metrology," page 377, will be found in the following table:

*Weight of a diamond carat in different countries.*

| Countries. | Weight. | Countries. | Weight. |
|---|---|---|---|
| | *Gram.* | | *Gram.* |
| Turin | .2135 | Turkey | .2005 |
| Persia | .2095 | Spain | .1999 |
| Venice | .2071 | Java, Borneo | .1969 |
| Austro-Hungary | .2061 | Florence | .1965 |
| France | .2059 | Arabia | .1944 |
| Portugal, Brazil | .2058 | Egypt | .1917 |
| Germany | .2055 | Bologna | .1886 |
| England, British India | .2053 | Average weight of diamond carat | .2020 |
| Holland, Russia | .2051 | | |

## IMPORTS.

*Diamonds and other precious stones imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Glazier's. | Dust. | Rough or uncut. | Diamonds and other stones not set. | Set in gold or other metal. | Total. |
|---|---|---|---|---|---|---|
| 1867 | $906 | ..... | ..... | $1,317,420 | $291 | $1,318,617 |
| 1868 | 484 | ..... | ..... | 1,060,544 | 1,465 | 1,062,493 |
| 1869 | 445 | $140 | ..... | 1,997,282 | 23 | 1,997,890 |
| 1870 | 9,372 | 71 | ..... | 1,768,324 | 1,504 | 1,779,271 |
| 1871 | 976 | 17 | ..... | 2,349,482 | 256 | 2,350,731 |
| 1872 | 2,386 | 89,707 | ..... | 2,939,155 | 2,400 | 3,033,648 |
| 1873 | ..... | 40,424 | $176,426 | 2,917,216 | 326 | 3,134,392 |
| 1874 | ..... | 68,621 | 144,629 | 2,158,172 | 114 | 2,371,536 |
| 1875 | ..... | 32,518 | 211,920 | 3,234,319 | ..... | 3,478,757 |
| 1876 | ..... | 20,678 | 186,404 | 2,409,516 | 45 | 2,616,643 |
| 1877 | ..... | 45,264 | 78,033 | 2,110,215 | 1,734 | 2,235,246 |
| 1878 | ..... | 36,409 | 63,270 | 2,970,469 | 1,025 | 3,071,173 |
| 1879 | ..... | 18,889 | 104,158 | 3,841,335 | 538 | 3,964,920 |
| 1880 | ..... | 49,360 | 129,207 | 6,690,912 | 765 | 6,870,244 |
| 1881 | ..... | 51,409 | 233,596 | 8,320,315 | 1,307 | 8,606,627 |
| 1882 | ..... | 92,853 | 449,313 | 8,377,200 | 3,205 | 8,922,571 |
| 1883 | ..... | 82,628 | 443,996 | 7,598,176 | 2,081 | 8,126,881 |
| 1884 | 22,208 | 37,121 | 367,816 | 8,712,315 | (a) | 9,139,460 |
| 1885 | 11,526 | 30,426 | 371,679 | 5,628,916 | (a) | 6,042,547 |

*a* Not specified.

*Imports of substances not included in the foregoing table, 1868 to 1885, inclusive.*

| Fiscal years ending June 30— | Unmanufactured agates. | Bookbinders' and other manufactured agates. | Carnelian. | Brazil pebbles. | Amber. | Amber beads. | Unmanufactured coral. | Manufactured coral. | Unmanufactured meerschaum. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1868 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | $62,270 | ..... | $62,270 |
| 1869 | ..... | $70 | $269 | ..... | $427 | ..... | ..... | 22,417 | $6,407 | 29,590 |
| 1870 | ..... | ..... | 766 | ..... | 1,433 | ..... | ..... | 18,975 | 3,998 | 25,172 |
| 1871 | ..... | 1 | 661 | ..... | 180 | ..... | ..... | 37,877 | 698 | 39,417 |
| 1872 | ..... | 529 | 207 | ..... | 2,426 | ..... | $83 | 59,598 | 2,194 | 65,037 |
| 1873 | $151 | 1,310 | ..... | $1,237 | 1,534 | $595 | 230 | 63,805 | 5,608 | 74,470 |
| 1874 | 177 | 1,524 | ..... | ..... | 1,448 | 1,057 | 527 | 28,152 | 270 | 33,155 |
| 1875 | 520 | 5,165 | ..... | 57 | 7,169 | 715 | 1,278 | 33,567 | 2,902 | 51,373 |
| 1876 | 293 | 1,567 | ..... | ..... | 15,502 | 187 | 109 | 33,559 | 21,939 | 73,156 |
| 1877 | 579 | 1,904 | (a)69 | ..... | 17,307 | 329 | 718 | 28,650 | 9,304 | 58,860 |
| 1878 | 82 | 404 | ..... | 76 | 13,215 | 1,119 | 1,252 | 12,667 | 16,308 | 45,123 |
| 1879 | 138 | 364 | ..... | ..... | 17,821 | 203 | 147 | 11,327 | 19,088 | 49,088 |
| 1880 | 57 | 2,346 | ..... | ..... | 36,860 | 2,317 | 62 | 5,492 | 30,849 | 77,983 |
| 1881 | 486 | 1,700 | ..... | 5 | 42,400 | 1,102 | 89 | 2,501 | 72,754 | 121,037 |
| 1882 | 901 | 5,084 | ..... | 111 | 72,479 | 4,174 | 1,474 | 669 | 56,118 | 141,010 |
| 1883 | 14 | 2,895 | ..... | ..... | 40,166 | 3,472 | 681 | 1,303 | 58,885 | 107,416 |
| 1884 | ..... | 6,100 | ..... | 3,496 | 56,301 | 4,692 | 158 | (b) | 43,169 | 113,916 |
| 1885 | 124 | ..... | ..... | 6,541 | 21,722 | 3,242 | 659 | (b) | 42,590 | 74,878 |

*a* Not separately classified since 1877. *b* Not specified.

# FERTILIZERS.

## PHOSPHATE ROCK.

By David T. Day.

### SOUTH CAROLINA.

The production of phosphate rock in South Carolina increased during 1885, but the conservative influence of the Phosphate Miners' Exchange limited the extension of mining territory, as the mines already opened had capacity fully equal to the demands of the trade. The shipments from Charleston increased slightly. From Beaufort there was a decided increase, both in foreign and domestic shipments. Thus the total production, including foreign and domestic shipments and the home consumption, amounted to 437,856 long tons for the calendar year 1885, an increase of 40,118 tons over the calendar year 1884, or of 6,077 tons over the fiscal year 1884. Of this amount 189,096 tons were shipped from Charleston, an increase of 613 tons over 1884. From Beaufort 188,760 tons were shipped, an increase of 39,505 tons. The amount consumed by home fertilizer works, 60,000 tons, was about the same as the year before. This is all for the calendar year, while in the table to follow the years are trade years except 1885, in which the seven months are given to complete the calendar year.

*Phosphate rock (washed product) mined by the land and river mining companies of South Carolina.*

| Years ending May 31— | Land companies. | River companies. | Total. |
|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* |
| 1867 | 6 | ..... | 6 |
| 1868 | 12,262 | ..... | 12,262 |
| 1869 | 31,958 | ..... | 31,958 |
| 1870 | 63,252 | 1,989 | 65,241 |
| 1871 | 56,533 | 17,655 | 74,188 |
| 1872 | 36,258 | 22,502 | 58,760 |
| 1873 | 33,426 | 45,777 | 79,203 |
| 1874 | 51,624 | 57,716 | 109,340 |
| 1875 | 54,821 | 67,969 | 122,790 |
| 1876 | 50,566 | 81,912 | 132,478 |
| 1877 | 36,431 | 126,569 | 163,000 |
| 1878 | 112,622 | 97,700 | 210,322 |
| 1879 | 100,779 | 98,586 | 199,365 |
| 1880 | 125,601 | 65,162 | 190,763 |
| 1881 | 142,193 | 124,541 | 266,734 |
| 1882 | 191,305 | 140,772 | 332,077 |
| 1883 | 219,202 | 159,178 | 378,380 |
| 1884 | 250,297 | 181,482 | 431,779 |
| 1885 | 225,913 | 169,490 | 395,403 |
| 1885 (June 1 to December 31) | 149,400 | 128,389 | 277,789 |

The following table gives the distribution of the phosphates. The foreign shipments from Charleston decreased slightly over the previous year, but the shipments to domestic ports increased. The total amount

exported has increased. The shipments to the West have also increased, although manufactured fertilizers are sent westward in greater quantity than phosphate rock.

*Detailed statement of total foreign and coastwise shipments and local consumption since June 1, 1874.*

| Periods. | Shipments and consumption. | Beaufort. | Charleston. | Other points. | Total. |
|---|---|---|---|---|---|
| | | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| June 1, 1874, to May 31, 1875 | Foreign ports | 44,617 | 25,929 | ..... | 70,546 |
| | Domestic ports | 7,000 | 25,560 | ..... | 32,560 |
| | Consumed | ..... | 19,684 | ..... | 19,684 |
| | Total | 51,617 | 71,173 | ..... | 122,790 |
| June 1, 1875, to May 31, 1867 | Foreign ports | 50,384 | 25,431 | ..... | 75,815 |
| | Domestic ports | 9,400 | 28,831 | ..... | 38,231 |
| | Consumed | ..... | 18,850 | ..... | 18,850 |
| | Total | 59,784 | 73,112 | ..... | 132,896 |
| June 1, 1876, to May 31, 1877 | Foreign ports | 73,923 | 28,844 | ..... | 102,767 |
| | Domestic ports | 6,285 | 40,768 | ..... | 47,053 |
| | Consumed | ..... | 13,400 | ..... | 13,400 |
| | Total | 80,208 | 83,012 | ..... | 163,220 |
| June 1, 1877, to May 31, 1878 | Foreign ports | 100,619 | 21,123 | ..... | 121,742 |
| | Domestic ports | 8,217 | 60,729 | ..... | 68,946 |
| | Consumed | ..... | 17,635 | ..... | 17,635 |
| | Total | 108,836 | 99,487 | ..... | 208,323 |
| June 1, 1878, to May 31, 1879 | Foreign ports | 97,799 | 21,767 | ..... | 119,566 |
| | Domestic ports | 8,618 | 52,281 | ..... | 60,899 |
| | Consumed | ..... | 18,900 | ..... | 18,900 |
| | Total | 106,417 | 92,948 | ..... | 199,365 |
| June 1, 1879, to May 31, 1880 | Foreign ports | 47,157 | 14,218 | ..... | 61,375 |
| | Domestic ports | 13,346 | 94,002 | ..... | 107,348 |
| | Consumed | ..... | 22,040 | ..... | 22,040 |
| | Total | 60,503 | 130,260 | ..... | 190,763 |
| June 1, 1880, to May 31, 1881 | Foreign ports | 62,200 | 8,568 | ..... | 70,768 |
| | Domestic ports | 65,895 | 91,929 | ..... | 157,824 |
| | Consumed | ..... | 38,142 | ..... | 38,142 |
| | Total | 128,095 | 138,639 | ..... | 266,734 |
| June 1, 1881, to May 31, 1882 | Foreign ports | 89,581 | 22,905 | ..... | 112,486 |
| | Domestic ports | 57,465 | 111,314 | 7,875 | 176,654 |
| | Consumed | ..... | 42,937 | ..... | 42,937 |
| | Total | 147,046 | 177,156 | 7,875 | 332,077 |
| June 1, 1882, to May 31, 1883 | Foreign ports | 94,789 | 28,251 | ..... | 123,040 |
| | Domestic ports | 36,175 | 150,545 | 26,000 | 212,720 |
| | Consumed | ..... | 42,620 | ..... | 42,620 |
| | Total | 130,964 | 221,416 | 26,000 | 378,380 |
| June 1, 1883, to May 31 1884 | Foreign ports | 132,114 | 20,539 | ..... | 152,653 |
| | Domestic ports | 34,711 | 181,363 | 6,329 | 222,403 |
| | Consumed | 5,800 | 50,923 | ..... | 56,723 |
| | Total | 172,625 | 252,825 | 6,329 | 431,779 |
| June 1, 1884, to May 31, 1885 | Foreign ports | 111,075 | 11,495 | ..... | 122,570 |
| | Domestic ports | 30,963 | 161,700 | 13,170 | 205,833 |
| | Consumed | 12,000 | 55,000 | ..... | 67,000 |
| | Total | 154,038 | 228,195 | 13,170 | 395,403 |
| June 1, 1885, to Dec 31, 1885 | Foreign ports | 105,761 | 8,581 | ..... | 114,342 |
| | Domestic ports | 16,321 | 112,126 | ..... | 128,447 |
| | Consumed | 5,000 | 30,000 | ..... | 35,000 |
| | Total for seven months | 127,082 | 150,707 | ..... | 277,789 |

*Prices.*—The combination of producers called the "Phosphate Miners' Exchange," advanced the price of phosphates during 1885, and kept it uniform at $6.50 per long ton for "crude," and $7.50 for "hot-air dried" "land" rock delivered in Charleston. At the mines near Charleston both crude and hot-air dried are worth about 20 per cent. less. For the past two years some companies have ground the rock for treatment with acid at the same time that it is dried. This ground rock was sold for $2 per short ton more than hot-air dried; lately the price has declined to 50 cents above hot-air dried. "River" rock is worth intrinsically $1 less per ton than land rock, based upon its lower percentage of phosphoric acid, by which all the valuations are made. While the above prices ruled steadily during 1885, a marked change came shortly after the close of the year. In February, 1886, the Phosphate Miners' Exchange was dissolved and prices became irregular; they declined to $4.50 to $5 per ton for crude rock.

The problem of extending river mining to deeper water has been actively discussed during 1885. It is claimed that an advance in this direction has been made by the introduction of the Brotherhood dredge, mention of which was made in the preceding report. The machine differs from the ordinary clam-scoop dredge by having the scoop in parts like the petals of a tulip. In descending these are opened, and the points striking the smooth layer of phosphate rock are intended to break into it and close upon the loosened pieces. It is generally supposed to be a success. It brings up loose rock rapidly and has undoubtedly done good work in some strata, but whether deep-water mining has been successfully solved remains a question. Many doubt the machine's ability to break up thick strata with smooth surface in deep water. The only actual defect thus far encountered is that in breaking up smooth strata much extraneous matter is brought up. This goes with the phosphate directly to the crusher, giving no chance for separation.

The following is a list of the phosphate mining companies in South Carolina:

*List of phosphate mining companies in South Carolina.*

LAND COMPANIES.

Charleston Mining and Manufacturing Company, Ashley river.
Bolton mines, Ashley river.
C. C. Pinckney, Ashley river.
Rose Mining Company, Ashley river.
William Gregg, Ashley river.
Saint Andrew's Mining Company, Stono river.
A. B. Rose, Ashley river.
Wando Company, Ashley river.
J. F. Fishburne, Ashley river.
F. C. Fishburne, Edisto river.
L. N. Chisolm, Ashley river.
Cahill & Wise, Wando river.

Charles H. Drayton & Co., Ashley river.
Pacific Guano Company, Bull river.
E. Willis, Charleston.
G. H. Linstedt, Charleston.
Charleston Phosphate Company, Charleston.
Dotterer & Ravenel, Charleston.
D. W. Ebaugh, Charleston.
W. L. Bradley, Rantowle's creek.
C. O. Campbell, Charleston.
Kiawah Company, Charleston.

RIVER COMPANIES.

Coosaw Company, Coosaw river.
Farmers' Company, Coosaw river.
Oak Point Mining Company, Bull river.
Carolina Phosphate Company, limited, Beaufort.
Phosphate Mining Company, limited, Beaufort.
J. B. & J. Seabrook, Beaufort.
W. T. Seward & Co., Beaufort.
J. G. Taylor, Beaufort.
W. W. Farr, Beaufort.
Tideman & Venning, Charleston.
Sea Island Chemical Company, Saint Helena sound.
John Hanson, Charleston.

The quantity of phosphates used in manufacturing fertilizers in Charleston remains practically constant. The following is a list of those engaged in the manufacture and a table is given of the shipments of manufactured fertilizers from Charleston:

*List of manufacturers of superphosphates and fertilizers in South Carolina.*

| Name. | Capital. | Location. |
|---|---|---|
| Wando Phosphate Company | $100,000 | Ashley river. |
| Atlantic Phosphate Company | 200,000 | Do. |
| Stono Phosphate Company | 135,000 | Do. |
| Pacific Guano Company | 1,000,000 | Do. |
| Edisto Phosphate Company | 200,000 | Cooper river. |
| Etiwan Phosphate Company | 300,000 | Do. |
| Ashepoo Phosphate Company | 125,000 | Ashley river. |
| Charleston Phosphate Company | 50,000 | Do. |
| C. C. Pinckney Company | 100,000 | Do. |
| H. Bulwinkle Company | 50,000 | Do. |
| Wilcox, Gibbes & Co | 100,000 | Charleston. |
| Woodstock Lime Company | 100,000 | Woodstock. |
| Domestic Fertilizer Company | 50,000 | Columbia. |
| Sea Island Chemical Company | 100,000 | Beaufort. |
| W. T. Seward & Co | 500,000 | Do. |
| Port Royal Fertilizer Company | 125,000 | Do. |

*Statement of manufactured fertilizers shipped from Charleston since* 1878.

Calendar years.

| By— | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| South Carolina railway: | | | | | | | | |
| January | 6,789 | 6,559 | 17,449 | 14,930 | 18,391 | 17,721 | 21,443 | 23,299 |
| February | 12,662 | 14,445 | 17,368 | 18,523 | 19,837 | 32,618 | 29,171 | 27,175 |
| March | 15,019 | 12,044 | 10,814 | 18,721 | 12,107 | 21,626 | 18,118 | 26,846 |
| April | 1,795 | 2,513 | 2,761 | 3,599 | 1,711 | 2,971 | 5,019 | 4,813 |
| May | 44 | 53 | 707 | 189 | 548 | 729 | 441 | 210 |
| Northeastern railroad: | | | | | | | | |
| January | 879 | 285 | 1,381 | 2,186 | 2,424 | 5,430 | 5,194 | 7,070 |
| February | 1,817 | 3,231 | 3,366 | 3,256 | 5,362 | 9,708 | 12,318 | 11,398 |
| March | 3,371 | 2,731 | 3,382 | 4,939 | 7,285 | 9,091 | 7,822 | 10,570 |
| April | 1,579 | 634 | 957 | 3,044 | 955 | 1,638 | 2,413 | 2,001 |
| May | 141 | 48 | 201 | 28 | 198 | 216 | 220 | 119 |
| Charleston and Savannah railway: | | | | | | | | |
| January | 676 | 1,016 | 1,169 | 951 | 690 | 2,059 | 4,196 | 3,435 |
| February | 584 | 1,791 | 1,249 | 1,155 | 1,272 | 2,888 | 5,373 | 4,457 |
| March | 436 | 1,444 | 476 | 2,375 | 594 | 1,003 | 3,525 | 2,466 |
| April | 95 | 675 | 203 | 629 | 160 | 225 | 1,234 | 640 |
| May | 2 | 5 | 9 | 50 | 14 | 23 | 20 | 27 |
| Georgetown, Peedee, Santee, and Edisto steamers: | | | | | | | | |
| January to June | 1,263 | 1,364 | 2,560 | 2,950 | 2,002 | 3,517 | 6,309 | 6,869 |
| Total five months | 47,152 | 48,838 | 64,005 | 77,525 | 73,490 | 111,464 | 122,816 | 131,395 |
| For remainder of year | 4,848 | 11,162 | 15,995 | 25,000 | 29,000 | 20,000 | 17,184 | 18,605 |
| Grand total | 52,000 | 60,000 | 80,000 | 102,525 | 102,490 | 131,464 | 140,000 | 150,000 |

NORTH CAROLINA.

New localities, lying 25 to 50 miles to the north, west, and south from the field defined in the report for 1883 and 1884, have been found, and some slight use of the beds has been made, as indicated in the following extract from a letter from Dr. Charles W. Dabney, jr., director of the North Carolina Experiment Station:

"There are no agents in the field, but the people send specimens and descriptions showing that fragments of beds at least exist throughout a much larger territory than was at first supposed.

"The following analyses of these specimens have been made at the station:

*Analyses of North Carolina phosphates.*

| Kind. | Locality. | Sender and address. | Sand and insoluble matter. | Carbonate of lime. | Phosphate of lime. | Phosphoric acid. |
|---|---|---|---|---|---|---|
| | | | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* |
| Coprolite | Bladen county | D. A. Lamont, Brinkland | ..... | ..... | 16.56 | 7.56 |
| Do | do | do | ..... | ..... | 14.43 | 6.61 |
| Phosphate rock | ..... | General W. G. Lewis, Goldsborough. | 7.09 | 18.42 | 47.50 | 21.76 |
| Do | Pender county | ..... | 22.75 | 16.06 | 43.72 | 20.03 |
| | Edgecombe county | Dr. A. B. Nobles, Tarboro. | 43.32 | 14.55 | 21.52 | 9.86 |
| | | D. S. Cowan, Robeson | 38.99 | 7.67 | 25.13 | 11.50 |

"No attempts have been made at the utilization of the simple phosphates. The low price of Charleston phosphates, the vast quantity which may be said to be 'in sight' there and which can be prepared for the market on short notice, and the advantages explained in your report for 1883 and 1884, which Charleston possesses, have deterred capital from developing our phosphate fields for a time at least. The country through Duplin county, etc., is undulating, and the beds, though very easily and economically workable, are small. Still 40,000 tons of superphosphates are sold along the Wilmington and Weldon railroad, within 50 miles of the phosphates, every year. It was shown that crude North Carolina rock could be put on this railroad for about $3 per ton, and that it would make, with 650 pounds of 47° Baumè acid, good 12 per cent. soluble superphosphate. The rock must come into use eventually.

"Much more practical interest is being taken in the phosphatic conglomerate, which occurs in such masses near the surface at Castle Haynes, Rocky Point, etc. This is ground fine and sold at retail in bags for $7 and $8 per ton, to be used as lime, ashes, plaster, etc., have been used, that is, on clover, peas, grasses, winter crops, and as an ingredient of composts. The material, as marketed, contains 25 to 35 per cent. of phosphate and 50 to 60 per cent. of carbonate of lime. Mixed with German kainite and a large quantity of manure, and put through a good rotting, it will be understood that this makes a valuable farm fertilizer. This is getting to be the practice. Three mills are already doing a fair business in grinding this rock and others are proposed for next season. All the mills together sold about 4,000 tons of the ground conglomerate under the names 'carbo-phosphate,' 'lime phosphate' 'coprolite manure,' etc."

### FLORIDA.

*Distribution of phosphates.*—It was mentioned in the last report that phosphates have been noticed in several counties in Florida, particularly in Clay, Alachua, Duval, and Gadsden counties. During 1884 and the early part of 1885 explorations were made by Dr. Lawrence C. Johnson which threw considerable light upon the situation of these deposits and the chances of their being utilized as fertilizers.

The deposits follow an irregular line from Thomasville, Georgia, down through Hamilton, Suwanee, Alachua, Marion, Sumter, and Polk counties, disappearing in Manatee county in the region of Charlotte Harbor. They have been noticed more particularly from Live Oak, Suwanee county, to Ocala, in Marion county, and only this region has been studied with any care. The region north has been traced by popular report, not by careful survey. South of Ocala the information is by no means exact, but many specimens have been examined which seem to ally the rock to that northward. The deposits are in high land, and the line of phosphates is generally coincident with the upper part of a

ridge running approximately north and south and containing the highest elevations in the State. The phosphates may be said, therefore, to extend along the backbone of the State. As usual, the elevation of this ridge has become very irregular by processes of erosion, and hence the deposits of phosphates jut out irregularly along the line traced out. In many places erosion by floods, etc., has carried large quantities of phosphatic bowlders to adjacent lower tracts of land.

*Character of the rock.*—Commencing with the upper limits of the deposit, it is impossible to say how much of the rock is really phosphatic and how much is Vicksburg limestone, with which the former has been confused. From Live Oak to Ocala there is little of the limestone, but the phosphate rock is very abundant. It is usually a very porous rock, containing through its mass the bones and teeth of various vertebrates, principally reptiles and sharks, with a few obscure casts of mollusks. In badly-drained spots it is wet and then soft, so that it can be easily broken, but on drying it becomes so much harder that it is valued as a building stone, and has been much used for chimneys and underpinning for houses; it is known as "chimney rock" by the people. In some localities the rock *in situ* is not so porous and contains more fossils. Geological observations make it appear that the deposits, which are estuary formations, extend through all the Tertiary strata, but are possibly more frequent in the Miocene. As the ridge with its phosphate deposit skirts the great region of depression which includes the sinks of Alachua county, it is probable that the phosphates mark an old shore line on the east side of a series of lagoons, of which the depressions are remnants. South of Ocala the character of the rock changes; it becomes oolitic in appearance, and seems to belong to a later formation. Here again there is no accurate information as to just how much of the rock is phosphatic. The deposits which have been carefully examined lie between Live Oak and Ocala. Of these the more interesting are the following:

*Preston's sink.*—Two and one-half miles north of Waldo, in Alachua county, there is a large dry sink in which Mr. John A. Preston found phosphate rock at a depth of 50 to 75 feet. The deposit is large and very abundant in fossils it is probably the richest in quality, the indications being that it may contain 25 per cent. phosphoric acid. At Fort Harley, 3½ miles north-northwest of Waldo, phosphate rock is found *in situ*. Santa Fé lake, in this same region, has many deposits around its borders.

*The Devil's Millhopper.*—This is another sink about 5 miles west of Gainesville. It contains loose bowlders of phosphate rock in large quantity. Near it is a large quarry of building rock, also phosphatic, situated 2 miles southwest of Gainesville. This is probably not as rich as the others, but it is of great extent.

*Simmon's quarry.*—Three miles west of Hawthorne, in Alachua county, there is a deposit in land which is slightly higher than the surrounding

country. There cannot be less than 35 acres of the deposit, and it may exceed 50 acres. It was analyzed by Prof. C. A. Colton, of Terre Haute, Indiana, as follows:

*Analysis.*

| | Per cent. |
|---|---|
| Calcium phosphate | 45.72 |
| Calcium carbonate | 22.00 |
| Moisture | 5.00 |

This is the only known quantitative analysis of phosphate rock in Florida.

*Newnansville.*—Three miles northwest of this place there is a very large deposit, the quality of which is unknown. Much phosphatic marl is also found on the Santa Fé river in this neighborhood.

*History and utilization.*—Dr. C. A. Simmons, of Hawthorne, was the first to discover that the principal building rock of central Florida contains a considerable amount of phosphoric acid. In 1879 he located the quarry near Hawthorne, and two years ago began mining the rock and converting it into a fertilizer, this has now been discontinued, owing to lack of capital. Dr. Simmons is thus entitled to the credit of first recognizing Florida phosphates. In 1884 Mr. John A. Preston noticed the peculiar odor characteristic of phosphate rock while digging out stone for a house foundation in the sink on his land near Waldo; finding also many sharks' teeth and bones; he tried it on some very poor land; it proved so valuable as a fertilizer that he has used it ever since. In the same year Judge James Bell, of Gainesville, discovered phosphates in the Devil's Millhopper. All the other deposits have been recognized as phosphates by Dr. Lawrence C. Johnson, United States Geological Survey.

Phosphate rock and phosphatic marl have been noticed in some isolated spots in other parts of the State. Some of these have been used locally as fertilizers; this is, however, the only test to which they have been subjected. At Enterprise an oölitic rock has been found similar to the southern part of the ridge deposits. The shell formation at Rock Ledge, on the Indian river, has been subjected to a quantitative analysis by Mr. G. M. Turner, of Johns Hopkins University, which showed a trace of phosphoric acid. At Black creek, in Clay county, phosphate rock similar to that in Alachua county has been found. In digging the pump well for the Jacksonville water works, on the northern boundary of the city, phosphates were noticed. The well is 50 feet in diameter and 32 feet in depth. At a depth of 20 to 23 feet a layer of greenish-brown marl 3 to 5 inches thick was found, which contained sharks' teeth and apparently considerable calcium phosphate. This layer is on top of rock composed of limestone from marine shells, sand, etc.; some of this limestone rock has such perfect casts of shells that they can be

dentified; there are also cavities in this rock filled with the phosphatic marl. Marl beds containing fossils have been observed by Mr. John F. Rollins on the bank of Fort George inlet, in Duval county, near the mouth of the St. John's river.

*Review.*—It seems probable that the phosphate beds already described are by no means the only ones in the State. Indeed, it is a common opinion that phosphates underlie nearly all of the so-called "high hammock land." This statement lacks verification, but the deposits already located should be sufficient to institute active measures towards their utilization. The prospect of manufacturing superphosphates from them is certainly as good as in the new field in North Carolina, the need of fertilizers is as great, and the competition of South Carolina rock less to be feared. As the matter rests now, it remains for the owners of the mines to repeat the energy shown by the North Carolina Experiment Station in finding by accurate analyses the phosphates which are best suited for manufacture. These will probably be found in the neighborhood of Gainesville, where the deposits are probably sufficiently rich, and freight facilities good. But experience has shown in other fields that good phosphates are frequently close beside those too poor in phosphoric acid to be profitably mined. Hence much careful selection and analytical work must precede the successful manufacture of fertilizers in Florida.

### MISSISSIPPI.

The cretaceous marls of Alabama, described in the last report, extend into Mississippi, and are found in many places in the northeastern portion of the State. Their occurrence, principally as greensand marls, in the greater portion of Tippah, Tishomingo, Pontotoc, Itawamba, Chickasaw, Monroe, Oktibbeha, Lowndes, Noxubee, and Kemper counties, was emphasized by Professor Hilgard in the State Geological Survey report published in 1860. This has led to considerable local use of the marls by the farmers as a dressing for the soil. Greensand and clay marls are met with in a line crossing the State from Vicksburg to the Alabama line. Tertiary marls are scattered quite generally over the southern portion of the State. In the neighborhood of Byram station and near Jackson, in Hinds county, and near Meridian, Lauderdale county, these marls have lately been sold as an ingredient for fertilizers, consisting principally of cotton-seed meal mixed with the marl. The largest deposit known in the State is near Shuqualak station, in Noxubee county; here the phosphoric acid reaches perhaps an average of 5 per cent. The deposit is similar to that at Coatopa, Alabama.

The analyses published by Hilgard and later reports from the State chemists limit the usual amount of phosphoric acid to 1 or 2 per cent.; but at the points mentioned 10 per cent. of phosphoric acid is claimed in some of the marls sold. The existence of beds of phosphatic nodules similar to those developed in Alabama has been traced into Mississippi, and their development will probably depend upon the result of the efforts to put the Alabama phosphates on the market. It is probable

that in the search for marls rich in phosphoric acid the fact has been partly overlooked that the greensand marls now in use are chiefly valuable from the amount of potassium salts which they contain.

### OTHER STATES.

In Georgia active preparations are being made to mine phosphate rock. In Glynn county the Georgia Phosphate Company owns 1,200 acres of phosphate deposits at the headwaters of the Little Satilla river. Operations will begin as soon as machinery can be put in at St. Simon's mill, where steam power is available. The company will also erect permanent works in Brunswick. Another factory for fertilizers is to be erected at Williams island. There has been no effort to use the phosphates extending south from Thomasville.

There have been no further developments of the phosphates and greensand marl in the Black Belt of Alabama, described by Professor Stubbs in the last report. In Arkansas it is proposed to open the mine at Crowley's ridge, in Crittenden county.

### FOREIGN SOURCES.

For a complete and extremely accurate report on all the foreign sources of phosphates, there is no better work than that published by Dr. Charles U. Shepard, jr., in the report of the Commissioner of Agriculture of South Carolina for 1880. Since the publication of that report the following changes in these sources have been made: The Ardennes and other deposits of coprolites in France have become more important sources of supply, and they may in time enter into the supply of England. The mines of Caceres, in the province of Estramadura, in Spain, increased their exports to England 53,600 tons in 1883, and there are indications of much greater activity throughout the province. A decline in the English prices will probably cause the erection of superphosphate works at Bilboa by the "Sociedad General de Fosfatos de Caceres." In 1884 there were only two small superphosphate works in all Spain, one in Logrono and one in Valencia. Phosphorite has also been found, but little worked, at Zarza la Mayor and Ceclavin, on the Portuguese border, in the province of Estramadura. The phosphorite here is unusually pure. A considerable deposit of phosphate rock has been discovered since the last report in the southwestern part of Tunis, by P. homas (*Chemiker Zeitung*, Vol. X). It occurs in the lower Tertiary strata, which extend over a large territory. The phosphate is found in cylindrical coprolites of all sizes, and in yellow bowlders weighing many pounds. These are accompanied also by smaller, white or sometimes dark-colored bowlders. The coprolites contain 70.80 per cent., the yellow bowlders 52.10 per cent., while the small black and white bowlders, which are more frequent, contain only 3.34 per cent. of tricalcium phosphate. The discoverer does not doubt their industrial application.

*Imports.*—The following tables show the imports from islands controlled by the United States, and also the regular importations of Pe-

ruvian guano, together with the ordinary phosphate occasionally brought from England:

*Guano brought from islands, rocks, and keys appertaining to the United States, 1869 to 1885, inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. | Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Long tons.* | | | *Long tons.* | |
| 1869 | 15,622 | $253,545 | 1878 | 17,930 | $211,239 |
| 1870 | 14,318 | 356,830 | 1879 | 8,733 | 95,137 |
| 1871 | 14,154 | 340,235 | 1880 | 12,795 | 147,051 |
| 1872 | 4,209 | 60,865 | 1881 | 16,883 | 179,882 |
| 1873 | 11,014 | 161,690 | 1882 | 15,249 | 160,016 |
| 1874 | 6,877 | 100,345 | 1883 | 7,873 | 92,130 |
| 1875 | 7,209 | 122,012 | 1884 | 9,333 | 106,431 |
| 1876 | 14,785 | 192,972 | 1885 | 12,100 | 86,166 |
| 1877 | 6,060 | 79,822 | | | |

*Phosphates imported and entered for consumption in the United States, 1868 to 1885, inclusive.*

| Fiscal years ending June 30— | Guano. | | Crude phosphates and other substances used for fertilizing purposes. | | Total value. |
|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | |
| | *Long tons.* | | *Long tons.* | | |
| 1868 | 99,668 | $1,336,761 | ..... | $88,864 | $1,425,625 |
| 1869 | 13,480 | 217,004 | ..... | 61,529 | 278,533 |
| 1870 | 47,747 | 1,414,872 | ..... | 90,817 | 1,505,689 |
| 1871 | 94,344 | 3,313,914 | ..... | 165,703 | 3,479,617 |
| 1872 | 15,279 | 423,322 | ..... | 83,342 | 506,664 |
| 1873 | 6,755 | 167,711 | ..... | 218,110 | 385,821 |
| 1874 | 10,767 | 261,085 | ..... | 243,467 | 504,552 |
| 1875 | 23,925 | 539,808 | ..... | 212,118 | 751,926 |
| 1876 | 19,384 | 710,135 | ..... | 164,849 | 874,984 |
| 1877 | 25,580 | 873,459 | ..... | 195,875 | 1,069,334 |
| 1878 | 23,122 | 849,607 | ..... | 285,089 | 1,134,696 |
| 1879 | 17,704 | 634,546 | ..... | 222,283 | 857,829 |
| 1880 | 8,619 | 108,733 | ..... | 317,068 | 425,801 |
| 1881 | 23,452 | 399,552 | ..... | 918,835 | 1,318,387 |
| 1882 | 46,699 | 854,463 | 133,955.50 | 1,437,442 | 2,291,905 |
| 1883 | 25,187 | 537,080 | 96,585.86 | 798,116 | 1,335,196 |
| 1884 | 28,090 | 588,033 | 16,542.00 | 237,594 | 825,627 |
| 1885 | 20,934 | 393,039 | 21,418.56 | 264,079 | 657,118 |

## APATITE.

There has been no effort to use the apatite occurring in the New England States, but the mines in Canada, particularly in Ottawa county, Quebec, are growing in importance, and those in Lanark, Leeds, and Frontenac counties, Ontario, are being slowly developed. An important deposit has been noticed at Lake Clear, Renfrew county, and there are a number of small beds in other parts of the Dominion. The mode of occurrence in Canada has been studied carefully by a number of expert engineers, and the following characteristics are summarized by Dr. Robert Bell, in the *Engineering and Mining Journal*, May 9, 1885:

"The apatite-bearing rocks appear to constitute one of the higher members of the Laurentian system. Although this system extends

over such vast tracts of country in the northern regions of the Dominion, rocks like those among which the apatite occurs appear to occupy but a small proportion of the whole area. In the great regions referred to scarcely anything is found but the commonest varieties of grayish and reddish feldspathic and quartzose gneiss, which are massive, highly crystalline, hard and granitoid. In the apatite regions, on the other hand, the rocks are, geographically speaking, arranged in great belts, differing more or less from one another and individually traceable for long distances. The limestone bands that they contain constitute the great distinguishing feature in which these strata differ from the bulk of the Laurentian rocks. While the common Laurentian gneiss holds but a small variety of minerals, the rocks of the apatite regions have already yielded upward of sixty species. Besides the limestone, the apatite regions have associated with them bands of schists, slates, pyroxenite, quartzite, jasper, etc. And they also contain serpentine, graphite, pyrite, pyrrhotite, and ores of iron, copper, lead, and other metals. In brief, the conditions under which apatite may always be sought are: A somewhat regular, large scale structural arrangement of the gneiss in bands, having distinctive characters and accompanied by limestones; a considerable number of Laurentian minerals, and the presence of pyroxenite or of mottled diorite. The author uses these signs to predict the discovery of apatite in the Parry Sound district and in the rocks northeast of Georgian bay. Apatite is sometimes found in large regular veins of a very ancient date, but in the great majority of cases the deposits, whether of the pure phosphate or a mixture of this with other minerals, appear to differ from the fissure veins, and to be extremely capricious and uncertain in their forms. The mineral is often mingled with the pyroxenite, but it always has a tendency to form itself into floors and branching veins, having two principal local courses. Dr. Bell believes these lines to mark approximately the original jointing of the rock. These ancient joints belong to three sets, two nearly vertical, intersecting each other, and one nearly horizontal, analogous to the three sets of dry joints of more recent date that are usually set in massive rocks at the present day. In the course of the disturbances to which these phosphate-bearing pyroxenites and gneisses were subjected, the angular masses into which they had been divided by these joints became in places separated and displaced, leaving the spaces that are now filled with the apatite. The process was one of segregation, and similar to that by which the irregular veins in other varieties of the Laurentian rocks have been filled with quartz and orthoclase. Tribasic phosphate of lime shows an unusually strong tendency to segregate or separate itself from mixtures containing it. Hence we should expect to find that even when it formed only a small proportion of the constituents of the rock in which the cavity occurred it would fill it up to the partial or complete exclusion of the more abundant minerals. There is little doubt that the apatite has been derived

principally from the pyroxenite. There is no evidence whatever that the Laurentian apatite has had the remotest connection with organic life, although it is a rather curious circumstance that the average proportion of fluorine in this anciently formed mineral should approximate that contained in the bones of mammals.

*Character of the mineral.*—Although the qualitative composition of the apatite in various mines is tolerably constant, the percentage of tricalcium phosphate differs slightly, but is usually between 80 and 90 per cent. Generally speaking it contains little oxide of iron. The various forms in which it is found in the Ottawa region are: As crystals sometimes of large dimensions in masses varying from compact to coarse granular, in strata of laminar texture, and in a friable variety which is abundant, known as "sugar phosphate." The latter on account of its friability is much easier to grind than the compact masses, but is harder to handle. The color varies through shades of green, blue, red, and brown; and it is sometimes yellow or white.

*Production.*—Mining these phosphates is of comparatively recent date and is carried on principally in the townships of Buckingham, Templeton, Portland, Hull, and Wakefield, in Ottawa county. The mines follow the Lièvre river, and are richer nearer the stream; the proportion of limestone increases with the distance from the bank. The apatite is rafted down the river, which is a deep sluggish stream, to the village of Buckingham, from thence it is taken by the Canadian Pacific railroad. Nearest to the railroad station is the Emerald mine, 9 miles up the river. This was one of the earliest opened, and is one of the most productive. The property includes 100 acres of land, all bought by the Ottawa Phosphate Company at a reported price of $100,000. The Washington mine adjoins the Emerald, and is being worked by a company of American capitalists. Desirous of developing the property they have removed a large amount of dead rock, and thus developed deposits of considerable extent. The Little Rapids mine, on the east side of the river, 2 miles farther north, is comparatively new. It has been opened very successfully by drifting. Next to this is the North Star mine, of an American company. At one place on this property a small "show" of phosphate on the surface only about 3 inches in width was selected for the spot where a test shaft should be sunk. At a depth of 100 feet this small vein was found to have widened out to 5 feet, and at a still farther depth it occupied the whole width and extent of the shaft. The High Rock mine lies on the west side of the Lièvre river, about 18 miles above Buckingham village, and is one of the extensive mines now worked. It belongs to the Phosphate of Lime Company of London. The property covers 1,200 acres, and the mine has been the most productive of all in Canada, having yielded during the four years of its present management 20,000 tons of high-grade phosphate. The profits of the last 3 years have been sufficient, according to Mr. H. B. Small, to cover all the outlay, and to admit of a divi-

dend of 25 per cent. last year. The Union mines, 1 mile farther south, belong to an American company owning 2,000 acres of land. The original capital, $100,000, was nearly all spent in plant, road making, etc. Yet, after one year's operations, a dividend of 30 per cent. was declared. The total production for Canada is given in the following table:

*Production of Canadian apatite from* 1878 *to* 1885 *inclusive.*

| Years. | Long tons. |
|---|---|
| 1878 | 3,701 |
| 1879 | 11,927 |
| 1880 | 7,974 |
| 1881 | 15,601 |
| 1882 | 17,181 |
| 1883 | 17,840 |
| 1884 | 22,143 |
| 1885 | 24,290 |

This table represents the shipments but does not fairly represent the production for the last year, since there is always a large amount mined too late in the winter to be transported to the railroad. This may hereafter be avoided by combined river and railroad transportation. The cost of a ton of phosphate delivered alongside a vessel in Montreal is from $7 to $10.50 at the most. Ocean freight ranges usually from $1.50 to $2 per ton. The price paid in Montreal varies from $12 to $22 per ton, according to the percentage of tricalcium phosphate. The higher the percentage becomes, the higher the unit of value. The average value in 1884 and 1885 was $17 per long ton. Although a large amount of American capital is invested in the mines, almost the whole of the apatite is shipped to Great Britain and continental Europe, only a trifling quantity finding its way to the United States. Considerable crude phosphate as well as large amounts of superphosphate are annually imported into the United States from England, and it is probable that much of the former is of Canadian origin, imported to aid in producing very high-grade superphosphates by firms in the northern States. The reason why Canadian phosphates thus cross the ocean twice is probably that, since American dealers were in the habit of importing from England before the Canada mines were developed, no effort has been made to turn the trade to a more direct course. It seems probable that the use of Canadian apatite may increase in the western States, particularly the rock from Kingston, Ontario.

## GYPSUM.

By H. S. Sproull.

*Eastern division.*—The report for 1884, page 809, gives a list of States in which gypsum occurs, and on pages 814 and 815 may be found an enumeration of the uses to which the mineral is applied. No additions

of any practical value have since been made, nor does the industry dif. fer in general from its condition in 1884, though in volume there is some falling off. Michigan and Ohio retain their position as the principal producing States, and indeed appear to contain within their borders the only rock from which it has yet been found possible to secure, through the usual course of burning and grinding, a merchantable article of plaster of Paris or stucco. Even this production is not entirely free from blemish, a granular or sandy condition being developed to a greater degree in the Michigan than in the Ohio product, though it serves all ordinary purposes of consumption. About 10,000 tons of rock are quarried in Virginia yearly and find comparatively local consumption for fertilizing purposes only, manufacturers evidently having found no inducement to attempt calcining. In the counties of Onondaga and Cayuga, New York, there is a considerable annual output from a stratum of slate and gypsum containing about 45 per cent. of the latter on the average. The two are so intermingled as to prevent a disintegration that would leave the gypsum in a proper condition for burning, and the mass of rock as quarried is, therefore, simply ground into land plaster of ordinary quality. Nothing reliable as to the amount of the product can be obtained. In other States the production from native deposits is of a desultory character and is unimportant in volume, and confined simply to the quarrying and grinding of the stone into proper condition for fertilizing purposes. The Grand River Plaster Company of Canada sends about 5,000 tons of white gypsum into the United States annually, nearly all of it going to the West to be used on the farming lands; and the quality is considered to be on a par with that of domestic production. During the early portion of 1885 a deposit of gypsum was struck in the western part of New York, but soon proved to be valueless, as shown by the following report from the Buffalo Cement Company, limited:

"Gypsum was discovered here at a depth of about 45 feet. The diamond-drill cores show that it extends down to a depth of 700 feet and is intermixed with layers of limestone and shale. It can never be utilized for commercial purposes on account of the great volume of water encountered, and a shaft started with the intention of working the mine has been abandoned."

The largest and most important production of calcined and land plaster is upon the Atlantic seaboard, and, as in 1884 and the year preceding, solely from imported stone supplied by the Nova Scotia quarries. Of the amount of gypsum received into the United States from this source, Maine receives about 10,000 tons annually, and the remainder of the importation, varying according to the requirements of trade, all gravitates toward the New York district. In 1885 the importation at the port of New York fell off 28,000 tons, as compared with 1884, due in a measure to the destruction by fire, early in the season, of one of the largest manufacturing establishments in the harbor, and in a measure, to lessened consumption. Of the 71,000 tons received, somewhat in

excess of 50 per cent. was used for fertilizing purposes, and the balance was calcined for trade use, indicating a production of about 218,000 barrels of 250 pounds net. The average cost of rock delivered at New York was $2.65 per ton, and the average price of the calcined product $1.25 per barrel.

According to official reports the production of gypsum in Nova Scotia in 1883 was 144,668 long tons; in 1884 it was 111,068 long tons; and in 1885 it was 87,644 long tons.

The gypsum beds of Nova Scotia contain the purest deposits yet discovered, and apparently are of sufficient magnitude to supply the present outlet for many years, but during the past two seasons somewhat annoying evidences of hard rock have been encountered, and the necessity for ultimately resorting to mining instead of quarrying is suggested.

The general condition of business during 1885 was somewhat dull under the influence of more careful methods of buyers, and a reduced consumption of both land plaster and the calcined product. The relations of manufacturing localities with the quarries, however, were of such a character that the output of stone could be fairly adjusted to actual requirements of the market, and a surplus accumulation was in consequence prevented. Prices were very well sustained at all points for the calcined goods, and there was a slight advance in the New York district. There appears to have been no special effort to widen the use of gypsum either in the old or new form, reports from all sections agreeing upon that point; but some experimenting has taken place. The claim is made that gypsum becomes harder by placing the calcined product for a few minutes in a mixture of water with 8 per cent. of sulphuric acid and then calcining again. Another suggestion is to immerse the freshly burned gypsum in a solution containing 90 parts of water and 10 parts of alum and then calcine again, with the assertion that the product will give a plaster, which after proper molding can be made to receive a polish like marble.

A considerable importation from Europe is reported yearly at New York under the name of gypsum. It is, however, as a matter of fact, only an artificial sulphate of lime made from the refuse of chemical factories at Newcastle, and brought out for the use of paper manufacturers. The importations have been as follows:

*Imports classed as gypsum at New York.*

| Years. | Packages. |
|---|---|
| 1881 | 1,472 |
| 1882 | 2,806 |
| 1883 | 3,563 |
| 1884 | 4,906 |
| 1885 | 3,692 |

Notwithstanding the inability to reach exact records of the quantity of gypsum calcined and ground on the seaboard, the proportion used for

fertilizing purposes is quite accurately given, and on the natural assumption that the remainder of the rock known to have been imported or quarried was converted into stucco a close approximation to the production may be made. Upon that basis the following table was prepared:

*Estimate of production of gypsum upon the Atlantic seaboard, principally from Nova Scotia stone.*

| Years. | Land plaster. | Stucco. |
|---|---|---|
| | *Long tons.* | *Barrels.(a)* |
| 1881 | 40,000 | 247,000 |
| 1882 | 45,000 | 332,000 |
| 1883 | 60,000 | 417,000 |
| 1884 | 63,000 | 358,000 |
| 1885 | 50,000 | 288,000 |

*a* 250 pounds net.

The following table gives the quantities and average values of the total imports of gypsum imported into the United States during the period from 1877 to 1885, through the port of New York, and the average price of calcined plaster during the same period:

*Amount of unground gypsum entered at the port of New York during the years* 1877 *to* 1885, *inclusive, and average prices per ton January* 1; *also price of calcined plaster per barrel.*

| Years. | Tons. | White lump, per ton. | Blue lump, per ton. | Calcined plaster, per barrel. |
|---|---|---|---|---|
| 1877 | 48,833 | $3.00 | $2.75 to 3.00 | $1.25 to 1.50 |
| 1878 | 42,575 | 3.00 | 2.75 to 2.80 | 1.15 to 1.25 |
| 1879 | 44,031 | 2.80 | 2.75 | 1.00 to 1.15 |
| 1880 | 60,952 | 3.25 to 3.50 | 3.00 to 3.25 | 1.00 to 1.15 |
| 1881 | 60,236 | 3.00 to 3.25 | 2.75 to 3.00 | 1.20 to 1.25 |
| 1882 | 77,463 | 3.75 to 4.00 | 3.00 to 3.25 | 1.30 to 1.40 |
| 1883 | 104,542 | 3.00 | 3.00 to 3.25 | 1.30 to 1.35 |
| 1884 | 99,144 | 3.00 | 2.75 | 1.30 to 1.35 |
| 1885 | 71,099 | 2.75 to 2.85 | 2.50 to 2.65 | 1.20 to 1.30 |

Nearly the entire export movement takes place at New York, and the following table gives a close record of the trade with foreign countries during the years named:

*Exports of calcined plaster from the port of New York,* 1877 *to* 1885, *inclusive.*

| Years. | Packages. | Value. | Years. | Packages. | Value. |
|---|---|---|---|---|---|
| 1877 | 17,083 | $26,040 | 1882 | 25,765 | $38,025 |
| 1878 | 17,257 | 23,073 | 1883 | 18,085 | 25,713 |
| 1879 | 11,732 | 14,902 | 1884 | 21,491 | 30,372 |
| 1880 | 11,191 | 15,321 | 1885 | 30,313 | 43,312 |
| 1881 | 17,391 | 24,419 | | | |

The production of Michigan is given in the following tables:

*Amount of land plaster and calcined plaster produced in Michigan.*

| Years. | Land plaster, short tons. | Stucco, barrels of 300 pounds. | Years. | Land plaster, short tons. | Stucco, barrels of 300 pounds. |
|---|---|---|---|---|---|
| Land plaster, previous to 1866 | 100,000 | ..... | 1875 | 27,019 | 61,120 |
| 1866 | 14,604 | ..... | 1876 | (a)39,131 | 64,386 |
| 1867 | 17,439 | ..... | 1877 | (a)40,000 | (a)55,000 |
| Stucco, previous to 1868 | ..... | (a)80 000 | 1878 | 40,000 | 48,346 |
| 1868 | 28,837 | 34,966 | 1879 | 43,658 | 50,800 |
| 1869 | 29,996 | 41,187 | 1880 | 49,570 | 106,004 |
| 1870 | 31,437 | 46,179 | 1881 | 33,178 | 112,813 |
| 1871 | 41,126 | 48,685 | 1882 | 37,821 | 135,165 |
| 1872 | 43,536 | 59,767 | 1883 | (a)40,082 | (a)159,100 |
| 1873 | 44,972 | 82,453 | 1884 | 27,868 | 156,677 |
| 1874 | 39,126 | 82,449 | 1885 | 28,181 | 141,575 |

*a* Partly estimated.

In 1883, 1884, and 1885 the total production of the several manufacturers in Michigan was as follows:

*Aggregate production of land and calcined plaster in Michigan during the years named.*

| Manufacturers. | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* |
| Grand Rapids Plaster Company | 9,843 | 6,528 | 7,928 |
| F. Godfrey & Brother | 9,968 | 8,940 | 8,887 |
| Noble & Co | 8,716 | 7,529 | 7,663 |
| Union Mills | 8,698 | 6,496 | 5,899 |
| Wyoming Mills | 7,483 | 4,925 | 5,656 |
| Alabastine Company | 9,415 | 8,307 | 5,053 |
| B. F. Smith | 9,227 | 7,545 | 7,317 |
| Total | 63,350 | 50,270 | 48,403 |

The production of Ohio is given by Mr. George A. Marsh, Sandusky, Ohio. The works and quarries are at Gypsum.

*Production of stucco and land plaster in Ohio.*

| Years. | Stucco. | | | Land plaster. | | |
|---|---|---|---|---|---|---|
| | Barrels. | Average price per barrel. | Total value. | Short tons. | Average price per ton. | Total value. |
| 1881 | 12,409 | $1.55 | $19,234 | 3,705 | $4.35 | $16,117 |
| 1882 | 16,888 | 1.46 | 24,676 | 4,404 | 4.33 | 19,069 |
| 1883 | 20,919 | 1.41 | 29,496 | 4,678 | 4.15 | 19,414 |
| 1884 | 20,307 | 1.38 | 28,024 | 4,217 | 4.09 | 17,218 |
| 1885 | (a)8,686 | 1.31 | 11,379 | 4,058 | 4.03 | 16,273 |

*a* This is the production of five months only, the mills having remained closed during the busiest portion of the season in consequence of the introduction of new machinery.

*Estimated total production of plaster in the United States during* 1885.

| | Land plaster. | Calcined plaster. | Total. |
|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* |
| From native stone | 49,100 | 26,000 | 75,100 |
| From imported stone | 51,500 | 46,200 | 97,700 |
| Total | 100,600 | 72,200 | 172,800 |

The estimated value of the product for 1885 was $379,500 for land plaster, and $580,100 for stucco or calcined plaster; total value, $959,600.

*Rocky Mountain division.*—Some new deposits have been discovered since the last report, but remain undeveloped, and have added nothing to the production. The bed of gypsum opened by the Colorado Stucco, Brick, and Cement Company, at Colorado City, is fully capable of supplying the entire demand from the country tributary to Denver for many years. There is consequently no incentive to open the numerous bodies of gypsum known to exist in all the Rocky Mountain territory. The production of Colorado City amounts to about 8,500 sacks, of 100 pounds each, yearly.

*Pacific division.*—There is little to be added to former remarks on the occurrence of gypsum in the States and Territories of the Pacific coast, no new discoveries of importance having been reported for that region during the past year. The manufacture of plaster from this material has, however, been sensibly increased, more especially in California, where 10 per cent. more plaster of Paris was made than during any previous year. The whole of this continues to be made at the Golden Gate mill in San Francisco, the only one on the coast. During the past year 2,500 tons of gypsum were received and ground at this mill, most of it coming from the deposits lately discovered in Santa Barbara county. A small quantity was imported from Lower California, whence the entire supply was formerly obtained. The increased consumption of plaster of Paris last year was due to a marked increase in building, more particularly in the city of San Francisco. The use of gypsum as a fertilizer continues to be limited on the Pacific coast, but as the soil becomes impoverished, it will, no doubt, gradually increase, and ultimately reach large proportions.

*Imports of plaster at San Francisco.*

| Years. | Barrels. | Years. | Barrels. |
|---|---|---|---|
| 1875 | 22,782 | 1881 | 5,850 |
| 1876 | 14,918 | 1882 | 4,777 |
| 1877 | 14,487 | 1883 | 6,300 |
| 1878 | 11,038 | 1884 | 5,700 |
| 1879 | 5,400 | 1885 | 9,690 |
| 1880 | 3,200 | | |

The decreased importation, from 22,782 barrels in 1875 to 9,690 in 1885, is due to a considerable home production.

Plaster of Paris was selling at the close of last year for $2.50 to $2.75 per barrel in San Francisco.

## TOTAL IMPORTS.

*Gypsum imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

[Long tons and hundredweights, of 2,240 and 112 pounds, respectively.]

| Fiscal years ending June 30— | Ground or calcined. | | Unground. | | Manufactured plaster of Paris. | Total. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | | |
| | *Tons.* | | *Cwts.* | | | |
| 1867 | | $29,895 | 1,959,020 | $95,386 | | $125,281 |
| 1868 | | 33,988 | 1,753,881 | 80,362 | | 114,350 |
| 1869 | | 52,238 | 2,740,785 | 133,430 | $844 | 186,512 |
| 1870 | | 46,872 | 2,144,733 | 100,416 | 1,432 | 148,720 |
| 1871 | | 64,465 | 2,008,010 | 88,256 | 1,292 | 154,013 |
| 1872 | | 66,418 | 1,906,787 | 99,902 | 2,553 | 168,873 |
| 1873 | | 35,628 | 2,378,520 | 122,495 | 7,336 | 165,459 |
| 1874 | | 36,410 | 2,474,350 | 130,172 | 4,319 | 170,901 |
| 1875 | | 52,155 | 1,875,440 | 115,664 | 3,277 | 171,096 |
| 1876 | | 47,588 | 2,794,263 | 127,084 | 4,398 | 179,070 |
| 1877 | | 49,445 | 1,953,120 | 105,629 | 7,843 | 162,917 |
| 1878 | | 33,496 | 1,784,774 | 100,102 | 6,989 | 140,587 |
| 1879 | | 18,339 | 1,939,259 | 99,027 | 8,176 | 125,542 |
| 1880 | | 17,074 | 2,406,540 | 120,642 | 12,693 | 150,409 |
| 1881 | | 24,915 | 2,572,140 | 128,107 | 18,702 | 171,724 |
| 1882 | 5,737.14 | 53,478 | 2,567,740 | 127,067 | 20,377 | 200,922 |
| 1883 | 4,291.34 | 44,118 | 3,157,020 | 152,982 | 21,869 | 218,969 |
| 1884 | 4,996.25 | 42,904 | 3,326,200 | 168,000 | (*a*) | 210,904 |
| 1885 | 6,418.00 | 54,208 | 2,343,220 | 119,544 | (*a*) | 173,752 |

*a* Not specified.

*Alabaster and spar ornaments imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1867 | $26,129 | 1877 | $16,000 |
| 1868 | 27,891 | 1878 | 8,148 |
| 1869 | 21,564 | 1879 | 7,986 |
| 1870 | 22,982 | 1880 | 9,730 |
| 1871 | 47,633 | 1881 | 19,078 |
| 1872 | 23,108 | 1882 | 34,292 |
| 1873 | 22,011 | 1883 | 23,179 |
| 1874 | 16,463 | 1884 | 38,982 |
| 1875 | 16,185 | 1885 | 31,796 |
| 1876 | 18,323 | | |

## MARLS.

The production of marls for use as fertilizers is limited to the sections in which marl can be had for the cost of digging, and even in such places its use is giving way to manufactured fertilizers. New Jersey has used more marl than all the rest of the country, but the substitution of superphosphates is increasing rapidly. The production of marl in New Jersey in 1885 amounted to perhaps 875,000 short tons, about the same as in 1884. As stated in connection with phosphates, the use of phosphatic nodules and marls in Alabama and Mississippi is extending, and will probably become a regular industry in the latter State.

## MANUFACTURED FERTILIZERS.

There has been little change in the sources of manufactured fertilizers. The amount of bones used has increased somewhat. This is felt particularly in the West, where the large amount of cattle killed and dressed before shipment to the East has increased the yield of bones very largely; these have been worked into fertilizers in the large western cities to supply the increasing demand for fertilizers in the Mississippi valley. There has been a corresponding increase in the domestic sources of nitrogen from the same slaughtered cattle, including dried blood, tankage, pork scrap, etc., and a decrease in the other sources of nitrogen, particularly sodium nitrate ("nitrate of soda"), which is used for fertilizers as well as in the manufacture of sulphuric acid. The use of crude ammonium sulphate imported from English gas works has also increased.

Among the mineral constituents of fertilizers, with which this report has particularly to deal, the South Carolina phosphates continue to be the great source of supply of phosphoric acid; but in regard to the sources of potassium, or "potash" as it is more frequently miscalled, there has been much agitation, particularly as to the relative value of the individual salts offered to the trade for furnishing potassium to the soil. The following description of the sources of potassium will show the different substances which enter into this discussion, with the advantages and disadvantages that have been claimed for each.

*Sources of potassium.*—The only source of potassium which this country utilizes is the carbonate of potassium or "potash lye" obtained from wood ashes. The aggregate of this substance made, particularly in a small way, all over the country is quite large, but not more than sufficient for use in a multitude of industries calling for "potash" in a tolerably pure and convenient form, so that practically none of the potash of domestic production enters into the composition of fertilizers. The large quantities demanded for this industry are imported from Germany in one of three forms, kainite, potassium chloride ("muriate of potash",) and medium and high grade potassium sulphate. Of these the most important is kainite. Although it does not contain as much potassium as either of the others, it is cheap, and has in its favor the prejudice of farmers who have tried it successfully on cotton and tobacco fields. It is sold with a guarantee that it shall contain 24 per per cent. potassium sulphate, $K_2SO_4$, and is sold "flat," that is, the purchaser has the advantage of all over 24 per cent. In 1885 the average price, delivered in the United States, was $8 per ton. It is sold nearly as dug from the earth at Stassfurt, Germany, being merely picked over, when sent to this country, so as to bring the percentage to the proper amount. Potassium chloride ("muriate of potash") is sold in increasing quantities. It is much richer in potassium than kainite; it is sold on a

basis of 1.75 cents per pound when 80 per cent. pure. If the analysis shows any lot to be purer than this an additional charge is added. It is still a much disputed question whether potassium chloride is sufficiently superior to kainite, agriculturally, to justify the difference in price, a difference maintained partly by the use of potassium chloride in other industries, such as the manufacture of potassium bichromate and potassium nitrate. It is not probable that the use of potassium chloride would have increased as it has done had it not been for the strong efforts of a syndicate of producers in Stassfurt to spread this substance, which they make from kainite, as part of the Stassfurt industry. It seems therefore that commercial causes, such as the effort to make a market for potassium chloride, have been the reason for the agitation against the use of kainite during 1885. The high grade and medium grade "sulphate of potash" is only sparingly used for fertilizers. A poor class of potassium compounds called kieserite is also used. The price for medium grade potassium sulphate was 1.2 cents in 1885. High grades were sold in proportion to their composition. Kieserite is also bought according to its composition. The amounts imported of these substances are given in the following tables. The tables of kainite imports and part of that for potassium chloride have been arranged from the trade lists of imports. The remainder was obtained from the Bureau of Statistics.

*Imports of potassium chloride (muriate of potash) from* 1872 *to* 1885, *inclusive.*

| Fiscal years ending June 30— | Tons. | Value. | Fiscal years ending June 30— | Tons. | Value. |
|---|---|---|---|---|---|
| 1872 | 2,579 | $126,418 | 1879 | 9,524 | $250,818 |
| 1873 | 3,467 | 158,768 | 1880 | 10,725 | 331,489 |
| 1874 | 3,323 | 134,289 | 1881 | 10,179 | 335,799 |
| 1875 | 5,242 | 190,587 | 1882 | 19,409 | 743,825 |
| 1876 | 4,413 | 157,542 | 1883 | 13,729 | 535,259 |
| 1877 | 6,153 | 209,413 | 1884 | 21,751 | 731,409 |
| 1878 | 8,784 | 292,603 | 1885 | 20,420 | 613,674 |

*Distribution of potassium chloride imports from* 1881 *to* 1885, *inclusive.*

| Ports | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| New York | 8,290 | 11,600 | 12,620 | 13,730 | 13,870 |
| Philadelphia | ..... | 2,117 | 1,599 | 1,645 | 1,850 |
| Baltimore | 4,155 | 4,406 | 3,500 | 2,896 | 2,290 |
| Boston | ..... | ..... | ..... | ..... | 1,594 |
| Charleston | ..... | ..... | ..... | ..... | 1,097 |
| Savannah | ..... | ..... | ..... | ..... | 50 |
| Port Royal | ..... | ..... | ..... | ..... | 150 |
| Other ports | ..... | ..... | ..... | ..... | 295 |
| Total | 12,445 | 18,123 | 17,719 | 18,271 | 21,196 |

The potassium chloride above is sold on a basis of 80 per cent. It is frequently less pure than this, and is then imported as "agricultural

salt," of which the following amounts have been imported, containing usually about 70 per cent. pure potassium chloride:

*Imports of agricultural salt from* 1869 *to* 1885.

| Fiscal years ending June 30— | Tons. | Value. | Fiscal years ending June 30— | Tons. | Value. |
|---|---|---|---|---|---|
| 1869 | | $1,752 | 1880 | | $21,667 |
| 1870 | | 9,698 | 1881 | | 8,187 |
| 1871 | | 2,436 | 1882 | | 55,622 |
| 1874 | | 114 | 1883 | | 43,363 |
| 1875 | | 1,867 | 1884 | 1,400 | 42,640 |
| 1879 | | 2,480 | 1885 | 600 | 18,360 |

*Distribution of kainite imports from* 1881 *to* 1885, *inclusive.*

| Ports. | Years. | | | | |
|---|---|---|---|---|---|
| | 1881. | 1882. | 1883. | 1884. | 1885. |
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| New York | 31,045 | 7,127 | 24,012 | 24,119 | 16,967 |
| Philadelphia | | 10,204 | 4,579 | 15,120 | 14,102 |
| Baltimore | 40,645 | 12,315 | 30,738 | 22,146 | 24,984 |
| Charleston | | 14,823 | 25,050 | 27,975 | 16,335 |
| Savannah | | 4,169 | 8,365 | 5,371 | 2,488 |
| Wilmington, N. C | | 5,494 | 9,020 | 13,355 | 9,330 |
| Boston | | | | | 492 |
| Norfolk | | | | 991 | 500 |
| Other ports | | | | 1,851 | 2,437 |
| Total | 71,690 | 54,132 | 101,764 | 110,928 | 87,635 |

*Imports of medium grade potassium sulphate* (*containing* 48 *to* 50 *per cent.* $K_2SO_4$).

| Years. | Short tons. | Years. | Short tons. |
|---|---|---|---|
| 1880 | 300 | 1883 | 1,000 |
| 1881 | 500 | 1884 | 2,500 |
| 1882 | 700 | 1885 | 7,525 |

Of high-grade potassium sulphate 450 short tons were imported in 1885.

*Prices.*—During 1885 kainite sold quite uniformly at $8 per long ton. The price of the other sources of potassium is kept uniform by the German syndicate at $1\frac{3}{4}$ cents per pound for potassium chloride which is 80 per cent. pure, and a proportional advance for higher percentages. Medium potassium sulphate sells at $1.20 per hundred pounds.

*Methods of manufacture.*—There has been little change in the methods of making fertilizers, except mechanical improvements in grinding phosphate rock and in drying it thoroughly at the time it is taken from the water. The proportion of sulphuric acid to rock is now less than in England, where the extreme cheapness of acid makes it profitable to use more. But both England and Germany have taken the lead in a new, manufacture which may have great significance for the fertilizer trade and will doubtless be a feature in American works before the next report. This is in the use of basic iron slags as a fertilizer.

*The Thomas-Gilchrist slag as a fertilizer.*—Reference was made in the last report to a patent obtained in 1882 by G. Rocour, of Luttich, Germany, for using the phosphorus found to a greater or less extent in iron slags; and to the modification by which C. Scheibler, in 1884, actually put these slags to practical use. But just at this time the Thomas-Gilchrist process for producing good iron from ores containing phosphorus began a revolution in the manufacture of iron, the importance of which cannot yet be fully measured. The process consists, in a word, in making a lining to the furnace of some highly basic material, such as lime, and introducing a much greater proportion of lime into the slag material than in older processes; with this arrangement, ores containing so much phosphorus as to render them worthless in the ordinary process are converted into good iron, the phosphorus going into the slag as calcium phosphate. The slag as now produced crumbles easily to a kind of meal. It contains much lime, but also phosphoric acid to the amount of 15 to 20 per cent. This large percentage of phosphate rendered the slag admirably suited for Scheibler's process, to which it was applied at Schalke and Stolberg. But meanwhile chance experiments showed that this slag itself, when applied to land in the form of meal, has acted in well recorded cases as a good fertilizer. These trials have not been limited to one place, nor to one experimenter, but both in England and Germany the testimony shows an agricultural value for this raw slag which is comparable, though probably not equal, to that of superphosphates. The interest naturally awakened by such an application of what has been hitherto waste material is shown all through Europe. The value of the slag as a fertilizer seems established, and there is much discussion as to whether it is better to use it simply ground or converted into soluble phosphates. Besides calcium phosphate there is a large amount of lime which is frequently but not always useful. There is some metallic iron and a large percentage of ferrous oxide, which is supposed to be injurious, and also sulphides of iron and calcium. Further, the presence of lime prevents the use of the slag with manures containing nitrogen, as it causes liberation and waste of ammonia. It has been proposed to rid the slag of part of these materials by passing sulphur dioxide and air through it. This is said to convert the lime and sulphide of calcium into harmless gypsum, and to oxidize the iron. But in how far this process can be made complete and economical is very uncertain. It has been found that the price of hydrochloric acid is too high for Scheibler's process, and hence it seems that unless some new process is found the slag will be used in the crude state as a fertilizer. The use of the Thomas-Gilchrist process in America has begun. A large tract of iron ore in Virginia, too rich in phosphorus for the old process, has been bought by a Philadelphia company for use with the new method, and the production of a fertilizer from the slag will be part of the plant.

*Production and prices.*—Fertilizers are made and shipped during the winter and spring, hence the production is given to April 30 of each year. Mr. A. de Ghequier, secretary of the National Fertilizer Association, has computed the product from May 1, 1884, to April 30, 1885, at 1,023,500 short tons. It was produced by the following States:

*Estimated production of manufactured fertilizers, years ending April 30.*

| States. | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* |
| Alabama | 3,000 | 4,000 | 4,000 |
| Connecticut | 15,000 | 15,000 | 15,000 |
| Delaware | 40,000 | 45,000 | 50,000 |
| District of Columbia | 7,000 | 7,000 | 7,000 |
| Georgia | 25,000 | 30,000 | 35,000 |
| Illinois | 30,000 | 35,000 | 35,000 |
| Indiana | 3,000 | 4,000 | 5,000 |
| Iowa | 1,000 | 1,000 | 1,000 |
| Kentucky | 2,500 | 3,500 | 4,000 |
| Louisiana | 2,000 | 2,500 | 3,000 |
| Maine | 6,500 | 7,000 | 7,500 |
| Maryland | 260,000 | 290,000 | 300,000 |
| Massachusetts | 75,000 | 80,000 | 85,000 |
| Michigan | 2,000 | 3,000 | 3,000 |
| Missouri | 6,000 | 6,000 | 6,000 |
| New Jersey | 85,000 | 90,000 | 95,000 |
| New York | 90,000 | 95,000 | 100,000 |
| North Carolina | 15,000 | 15,000 | 15,000 |
| Ohio | 15,000 | 15,000 | 18,000 |
| Pennsylvania | 60,000 | 65,000 | 70,000 |
| Rhode Island | 12,000 | 12,000 | 12,000 |
| South Carolina | 90,000 | 100,000 | 110,000 |
| Virginia | 30,000 | 40,000 | 40,000 |
| West Virginia | 2,000 | 2,000 | 3,000 |
| Total | 877,000 | 967,000 | 1,023,500 |
| Value | $23,680,000 | $26,110,000 | $27,640,000 |

By obtaining statements of fertilizer shipments from the various transportation lines, Mr. de Ghequier has been able to approximate the consumption in the following States:

*Estimated consumption of manufactured fertilizers in the following States, years ending April 30.*

| States. | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* |
| Alabama | 45,000 | 45,000 | 45,000 |
| Delaware | 10,000 | 20,000 | 20,000 |
| Florida | 5,000 | 5,000 | 10,000 |
| Georgia | 125,000 | 170,000 | 180,000 |
| Illinois | 5,000 | 7,500 | 7,500 |
| Indiana | 8,000 | 8,000 | 10,000 |
| Kentucky | 6,000 | 6,000 | 10,000 |
| Louisiana | 5,000 | 5,000 | 5,000 |
| Maryland | 80,000 | 75,000 | 75,000 |
| Michigan | 5,000 | 5,000 | 5,000 |
| Mississippi | 20,000 | 10,000 | 10,000 |
| Missouri | 5,000 | 5,000 | 5,000 |
| New York | 30,000 | 30,000 | 35,000 |
| New Jersey | 35,000 | 40,000 | 45,000 |
| New England States | 60,000 | 75,000 | 100,000 |
| North Carolina | 90,000 | 95,000 | 90,000 |
| Ohio | 20,000 | 20,000 | 20,000 |
| Pennsylvania | 80,100 | 100,000 | 100,000 |
| South Carolina | 90,000 | 110,000 | 100,000 |
| Tennessee | 10,000 | 10,000 | 15,000 |
| Virginia and West Virginia | 80,000 | 100,000 | 100,000 |
| Western States | 26,000 | 25,000 | 30,000 |
| | 840,100 | 966,500 | 1,017,500 |

Some of each year's product is left on hand at the end of the year, so that the total production and consumption are not the same. From May 1, 1885, to April 30, 1886, the production will be the same as for the previous year, within a few tons. The consumption will be less, viz., about 1,006,631 tons.

*Valuation.*—The agricultural experimental stations and State boards of agriculture in many of the southern States endeavor, in addition to analyzing all the fertilizers sold, to make values for them on the basis of these analyses. These values are obtained by assigning a definite value per pound for each constituent of a fertilizer, finding the number of pounds per ton of each, and thus arriving at a value which is a good basis for comparing different fertilizers. But whether it would represent the absolute value of each one would depend upon the value given for one pound of each component. Since this value cannot be uniform for different places, the valuation cannot be the fixed price at which the fertilizer shall be sold. But, unfortunately, the consumers of fertilizers, not caring to study the meaning of analyses, accept the official relative valuations for more than they are intended, and hence they produce such confusion between buyer and manufacturer that the system becomes of doubtful value. The values adopted in North Carolina during 1884–85 were the average values of a pound of each constituent in the principal interior towns, that is:

| | Per pound. |
|---|---|
| | *Cents.* |
| Available phosphoric acid | 9 |
| Ammonia | 20 |
| Potash | 5 |

The values for 1885–86 are for the principal seaports, and are uniform in most of the southern States.

| | Per pound. |
|---|---|
| | *Cents.* |
| Available phosphoric acid | 7½ |
| Ammonia | 16 |
| Potash | 5 |

The method by which these analyses are made public is shown in the appended table, taken from the monthly bulletin of the Department of Agriculture in South Carolina.

*Analyses of fertilizers by the South Carolina Department of Agriculture, season of* 1884–'85.

[Philip E. Chazal, E. M., chemist.]

| Sample drawn. | Where drawn. | Brand of fertilizer. | Moisture. | Phosphoric acid. | | | | | Potential ammonia. | Potash. | Commercial value per 2,000 pounds. | Manufacturer's minimum guarantee. | | | | By whom manufactured. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total. | Insoluble. | Soluble. | Reduced or reverted. | Available. | | | | Available phosphoric acid. | Potential ammonia. | Potash ($K_2O$.) | Commercial value per 2,000 pounds. | |
| 1885. | SOUTH CAROLINA. | | | | | | | | | | | | | | | |
| Mar. 2 | Darlington | Ash Element | 5.85 | 10.50 | .... | .... | .... | .... | .... | 4.13 | $4.13 | (*a*) | .... | 3.00 | $3.00 | Stono Phosphate Company, Charleston. |
| 12 | Marion | Ashepoo Dissolved Bone with Ammonia and Potash. | 13.65 | 13.70 | 3.52 | 7.30 | 2.88 | 10.18 | 1.24 | 1.54 | 18.49 | 10.00 | 1.00 | 1.00 | 17.00 | Ashepoo Phosphate Company, Charleston. |
| 13 | Marion | Acabee Fertilizer | 11.90 | 11.33 | 2.27 | 6.27 | 2.79 | 9.06 | 2.89 | 2.07 | 22.52 | 8.00 | 2.00 | 1.00 | 17.40 | Ashepoo Phosphate Company, Charleston. |
| 21 | Columbia | Acid Phosphate | 14.08 | 14.40 | 2.05 | 9.02 | 3.33 | 12.35 | .... | 0.98 | 17.04 | 10.00 | .... | 1.00 | 14.00 | Georgia Chemical Works, Augusta, Ga. |
| 27 | Batesburg | Alkaline Guano, the Great Potash Fertilizer. | 13.20 | 12.74 | 2.88 | 7.30 | 2.56 | 9.86 | 2.38 | 1.54 | 21.50 | 10.00 | 2.00 | 1.50 | 20.50 | |
| May 20 | Orangeburg | Ammoniated Bone Superphosphate. | 15.00 | 10.53 | 1.28 | 7.17 | 2.08 | 9.25 | 2.93 | 2.37 | 23.19 | 10.00 | 2.43 | 1.50 | 21.79 | E. Frank Coe, 16 Burling slip, New York. |
| Jan. 28 | Anderson | Bone Superphosphate | 17.43 | 13.31 | 4.13 | 5.95 | 3.23 | 9.18 | 0.58 | 1.64 | 15.31 | 10.00 | .... | 1.50 | 14.50 | Russell Coe, Linden, N. J. |
| May 2 | Orangeburg | Bone Meal | 6.78 | 19.32 | .... | .... | .... | .... | 4.04 | .... | .... | .... | .... | .... | .... | |
| Feb. 12 | Chester | Baltimore Crown Guano | 13.45 | 11.33 | 3.28 | 5.25 | 2.80 | 8.05 | 2.08 | 2.16 | 18.47 | 8.00 | 2.00 | (*b*) 1.00 | 20.70 | Chesapeake Guano Company, Baltimore. |
| Mar. 13 | Marion | Baltimore Soluble Bone | 15.95 | 14.85 | 2.05 | 7.87 | 4.93 | 12.80 | .... | .... | 16.64 | 12.00 | .... | .... | 15.60 | Baltimore Guano Company, Baltimore. |
| 28 | Trenton | Bald Eagle | 12.70 | 12.64 | 4.13 | 6.27 | 2.24 | 8.51 | 2.03 | 1.47 | 18.62 | 8.00 | 2.00 | 1.00 | 17.40 | Georgia Chemical Works, Augusta, Ga. |
| Feb. 19 | Camden | Cotton Seed Meal | .... | 2.16 | .... | .... | .... | .... | 8.00 | 1.53 | .... | .... | .... | .... | .... | Desoto Oil Company, Memphis. |
| Mar. 20 | Columbia | Cotton and Corn Compound | 12.20 | 7.81 | 1.07 | 4.74 | 2.00 | 6.74 | 3.25 | 2.90 | 21.41 | 6.00 | 3.25 | 3.00 | 20.55 | Ashley Phosphate Company, Charleston. |
| Feb. 25 | Timmonsville | Cotton Seed Meal | .... | 2.43 | .... | .... | .... | .... | 8.23 | 1.62 | .... | .... | .... | .... | .... | Charleston Oil Manufacturing Company, Charleston. |
| Mar. 28 | Johnston | Cranston's Ammoniated Dissolved Bone. | 19.05 | 10.56 | 1.98 | 6.53 | 2.02 | 8.58 | 2.73 | 1.16 | 20.50 | 8.00 | 2.00 | 1.00 | 17.40 | R. P. Sibley, general agent, Augusta, Ga. |
| Jan. 28 | Anderson | Dissolved Bone | 16.60 | 11.26 | 2.56 | 6.78 | 1.92 | 8.70 | 2.23 | 0.89 | 18.89 | 8.71 | 2.00 | 0.58 | 17.90 | F. W. Wagner & Co., Charleston. |
| Mar. 21 | Columbia | Dissolved Bone Phosphate of Lime. | 14.10 | 15.94 | 2.99 | 9.60 | 3.35 | 12.95 | .... | .... | 16.84 | 10.00 | .... | .... | 13.00 | Pacific Guano Company. |

*a* Bone phosphate of lime 22 per cent. *b* Sulphate of potash.

The plan of branding with italics the fertilizers which fall even slightly below the manufacturer's guarantee has been severely criticized; for the method of collecting samples is not perfect enough to prevent good fertilizers from being included among bad, and thus permanently damaged.

*Methods of fertilizer analysis.*—At a meeting in Washington, in September, the Association of Official Agricultural Chemists recommended that the method of determining phosphoric acid which was adopted at Atlanta in 1884 should be followed rigorously during the coming year, with a few slight changes in applying the method to rock phosphates and natural guanos. It is possible that they will, however, soon follow the lead of the chemists of the experimental stations, and the manufacturers of south Germany, in adopting the method of Paul Wagner for determining phosphoric acid. This method, which is intended to compare the agricultural values of different phosphates, is based on experiments with plants which show that a certain solution of acid ammonium citrate will extract phosphoric acid from fertilizers in proportion to their ability to fertilize soil. Thus, bi-calcium phosphate is 30.6 per cent. as good a fertilizer as phosphoric acid, which is soluble in water, and the solution recommended dissolves this amount of phosphoric acid from bi-calcium phosphate. Again, a superphosphate from which the water-soluble phosphoric acid has been thoroughly washed is still able to fertilize 3 per cent. as well as phosphoric acid, and the solution also extracts this percentage from the fertilizer. The solution consists of 150 grams of citric acid dissolved in water, neutralized with ammonia, and diluted to 5 liters; then 10 grams of citric acid are added. The fertilizer is treated directly with this solution, and after standing for eighteen hours at the ordinary temperature of the room, the extracted phosphoric acid is determined as usual.

At the meeting of fertilizer manufacturers held at Mayence, on November 30, 1885, eight samples of different fertilizers were prepared by a commission of chemists and manufacturers and distributed to twelve laboratories. The variations between the separate analyses and the mean average were as follows:

| | "Soluble" phosphoric acid. |
|---|---|
| | *Per cent.* |
| I. With high-class superphosphate | ±0.27 |
| II. With high-class superphosphate | .38 |
| III. With phosphorite superphosphate | .30 |
| IV. With phosphorite superphosphate | .32 |
| Mean | ±0.32 |

Against this the variations in the determinations of the phosphoric acid soluble in water made by the same chemists amounted to—

| | Phosphoric acid soluble in water. |
|---|---|
| | *Per cent.* |
| I. With high-class superphosphate | ±0.39 |
| II. With high-class superphosphate | .36 |
| III. With phosphorite superphosphate | .13 |
| IV. With phosphorite superphosphate | .18 |
| Mean | ±0.26 |

From this we see that the mean differences in the determinations of the "soluble" phosphoric acid exceed those of the phosphoric acid soluble in water by only 0.06 per cent. The representatives of the manure manufacturers and those of the experimental stations of Bonn, Darmstadt, Speier, and Wiesbaden, have therefore agreed unanimously to accept this method for the analysis of all superphosphates from January, 1886, and in consequence thereof, to advertise in their price lists a guaranteed percentage of "soluble" phosphoric acid in the different superphosphates.

In the case of Thomas precipitated phosphate the results obtained were not sufficiently concordant, and the commission was requested to look closer into the matter and to report again in due course.

*Exports.*—In the calendar year 1885, 161,353 long tons of crude phosphates were exported, principally to England and Germany. Besides this, a small amount of manufactured fertilizers are also exported, record of which was kept to 1883, as follows:

*Fertilizers of domestic production exported from the United States, 1864 to 1883, inclusive.*

| Fiscal years ending June 30— | Guano. | | | Other substances used for manures. |
|---|---|---|---|---|
| | Quantity. | Value. | Average value. | |
| | *Long tons.* | | | |
| 1864 | | | | $40,353 |
| 1865 | | | | 47,896 |
| 1866 | | | | |
| 1867 | 2,203 | $25,395 | $11.53 | 28,360 |
| 1868 | 1 | 228 | | 35,404 |
| 1869 | | 3,220 | | 20,508 |
| 1870 | 1,551 | 61,097 | 39.39 | 53,913 |
| 1871 | 1,203 | 35,000 | 29.09 | 264,837 |
| 1872 | 193 | 11,601 | 60.11 | 427,797 |
| 1873 | 258 | 8,210 | 31.82 | 224,084 |
| 1874 | 90 | 4,325 | 48.06 | 279,551 |
| 1875 | 316 | 9,305 | 29.45 | 668,806 |
| 1876 | 156 | 4,859 | 31.15 | 917,362 |
| 1877 | 954 | 41,530 | 43.53 | 1,076,602 |
| 1878 | 161 | 3,720 | 23.11 | 1,208,049 |
| 1879 | 354 | 8,741 | 24.69 | 1,231,841 |
| 1880 | 475 | 14,891 | 31.35 | 588,777 |
| 1881 | 959 | 29,581 | 30.85 | 583,361 |
| 1882 | 681 | 24,870 | 36.52 | 997,499 |
| 1883 | 1,231 | 52,823 | 42.91 | 1,029,678 |

# SALT.

In accordance with the tendency indicated in 1884, the low price of salt has driven the production more and more into the hands of the large producers, principally in Michigan and New York, leaving the margin for profit in West Virginia and other States small indeed.

*Production.*—The following table shows the total production in barrels of 280 pounds in the United States during the last three years:

*Salt product of the United States in* 1883, 1884, *and* 1885.

| | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Barrels.* | *Barrels.* | *Barrels.* |
| Michigan | 2,894,672 | 3,161,806 | 3,297,403 |
| New York | 1,619,486 | 1,788,454 | 2,304,787 |
| Ohio | 350,000 | 320,000 | 306,847 |
| West Virginia | 320,000 | 310,000 | 223,184 |
| Louisiana | 265,215 | 223,964 | 299,271 |
| California | 214,286 | 173,571 | 221,428 |
| Utah | 107,143 | 114,285 | 107,140 |
| Nevada | 21,429 | 17,857 | 28,593 |
| Illinois, Indiana, Virginia, Tennessee, Kentucky, and other States and Territories, estimated | 400,000 | 400,000 | 250,000 |
| Total | 6,192,231 | 6,514,937 | 7,038,653 |

The total yield exceeded that of 1884 by 523,716 barrels. The total value of all salt produced was $4,825,345, an increase of $627,611, which was due partly to the increased value of the Michigan product and also to the large increase in production in western New York.

*Michigan.*—According to the "Mineral Resources of Michigan," by Commissioner Charles D. Lawton, Michigan produced in 1885 more than one-third of all the salt consumed in the United States, and within a fraction of one-half of the total production. The advantages which the manufacturers of salt in this State possess include very rich brines and large lumber mills near by, thus securing slabs, pine sawdust, and waste steam at no cost, as the salt wells and lumber mills are worked by the same companies. Six new steam salt blocks were erected at Manistee, three at Ludington, one at Algonac, one at Frankfort, and four at Marine City, which go into operation during 1886. The estimated capacity of these new blocks is 700,000 barrels. The average depth of salt wells in Michigan is about 880 feet and the average strength of the brine is 91¼°. The manufacture of salt in Michigan

began in 1860. In 1869 the present law, requiring all salt to be inspected, went into effect. The yield since that time is given in the tables to follow.

*Salt made in Michigan, 1880 to 1885, inclusive, by counties.*

[Barrels of 280 pounds each, as in each subsequent reference in this section.]

| Counties. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| | *Barrels.* | *Barrels.* | *Barrels.* | *Barrels.* | *Barrels.* | *Barrels.* |
| Bay | 1,081,841 | 1,107,617 | 1,158,279 | 1,106,461 | 1,110,445 | 951,810 |
| Gratiot | ..... | ..... | 3,285 | 6,186 | 3,500 | 3,115 |
| Huron | 256,841 | 326,852 | 255,012 | 256,965 | 313,832 | 306,664 |
| Iosco | 147,800 | 147,579 | 211,667 | 240,644 | 224,687 | 236,543 |
| Manistee | ..... | 1,642 | 41,562 | 48,544 | 123,033 | 432,637 |
| Midland | 41,462 | 74,537 | 80,239 | 66,135 | 65,726 | 62,710 |
| Saginaw | 1,148,644 | 1,083,990 | 1,287,273 | 1,185,957 | 1,245,912 | 1,178,910 |
| Saint Clair | ..... | ..... | ..... | 4,780 | 74,671 | 125,014 |
| Total | 2,676,588 | 2,742,217 | 3,037 317 | 2,885,672 | 3,161,806 | 3,297,403 |

The following table shows the amount of salt inspected in Michigan since 1869, the first year of the establishment of the State salt inspection, for the years specified:

*Grades of salt made in Michigan as reported by the inspectors.*

| Years. | Fine. | Packer's. | Solar. | Second quality. | Total for each year. |
|---|---|---|---|---|---|
| | *Barrels.* | *Barrels.* | *Barrels.* | *Barrels.* | *Barrels.* |
| 1869 | 513,989 | 12,918 | 15,264 | 19,117 | 561,288 |
| 1870 | 568,326 | 17,869 | 15,507 | 19,650 | 621,352 |
| 1871 | 655,923 | 14,677 | 37,645 | 19,930 | 728,175 |
| 1872 | 672,034 | 11 110 | 21,461 | 19,876 | 724,481 |
| 1873 | 746,702 | 23,671 | 32,267 | 20,706 | 823,346 |
| 1874 | 960,757 | 20,090 | 29,391 | 16,741 | 1,026,979 |
| 1875 | 1,027,886 | 10,233 | 24,336 | 19,410 | 1,081,865 |
| 1876 | 1,402,410 | 14,233 | 24,418 | 21,668 | 1,462,729 |
| 1877 | 1,590,841 | 20,389 | 22,949 | 26,818 | 1,660,997 |
| 1878 | 1,770,361 | 19,367 | 33,541 | 32,615 | 1,855,884 |
| 1879 | 1,997,350 | 15,641 | 18,020 | 27,029 | 2,058,040 |
| 1880 | 2,598,037 | 16,691 | 22,237 | 48,623 | 2,685,588 |
| 1881 | 2,673,910 | 13,885 | 9,683 | 52,821 | 2,750,299 |
| 1882 | 2,928,542 | 17,208 | 31,335 | 60,222 | 3,037,307 |
| 1883 | 2,8[illegible]8,987 | 15,424 | 16,735 | 33,526 | 2,894,672 |
| 1884 | 3,087,033 | 19,368 | 16,957 | 38,508 | 3,161,806 |
| 1885 | 3,230,646 | 15,480 | 19,849 | 31,428 | 3,297,403 |

*Salt production of Michigan previous to 1869.*

| Years. | Barrels. | Years. | Barrels. |
|---|---|---|---|
| 1860 | 4,000 | 1865 | 477,200 |
| 1861 | 125,000 | 1866 | 407,077 |
| 1862 | 243,000 | 1867 | 474,721 |
| 1863 | 466,356 | 1868 | 555,690 |
| 1864 | 529,073 | | |

*Average price of Michigan salt in different years, 1866 to 1885, inclusive.*

| Years. | Price per barrel. | Years. | Price, per barrel. |
|---|---|---|---|
| 1866 | $1.80 | 1876 | $1.05 |
| 1867 | 1.77 | 1877 | 85 |
| 1868 | 1.85 | 1878 | 85 |
| 1869 | 1.58 | 1879 | 1.02 |
| 1870 | 1.32 | 1880 | 75 |
| 1871 | 1.46 | 1881 | 85 |
| 1872 | 1.46 | 1882 | 75 |
| 1873 | 1.37 | 1883 | 81 |
| 1874 | 1.19 | 1884 | 75 |
| 1875 | 1.10 | 1885 | 90 |

The total value of the salt made in Michigan in 1885 was $2,967,663.

*New York.*—The total production of salt in the State during 1885 was 11,523,934 bushels of 56 pounds each, with a total value of $874,258. The Onondaga reservation contributed 6,934,299 bushels to the above total; and the Warsaw district, together with the outlying wells, 4,589,635 bushels, according to the manufacturers' returns. The production for the past three years has been:

| | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* |
| Onondaga reservation | 7,497,431 | 6,942,270 | 6,934,299 |
| Warsaw district | 600,000 | 2,000,000 | 4,589,635 |
| Total | 8,097,431 | 8,942,270 | 11,523,934 |

Of the production on the Onondaga salt reservation, Mr. P. J. Brummelkamp reports that 4,494,967 bushels were produced in the fine-salt works by artificial heat, and 2,139,332 bushels of coarse solar salt. The total for the reservation is nearly the same as last year; it is divided among the following districts, the production of each of which is given for 1885:

*Salt inspected at the Onondaga salt springs in 1885.*

| Places. | Solar. | Fine. | Ground solar. | Fine growth. | Aggregate. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| Syracuse, district No. 1 | 307,709 | 818,917 | 61,397 | 138,494 | 1,329,517 |
| Salina, district No. 2 | 597,871 | 1,151,232 | 65,451 | 178,596 | 1,993,150 |
| Liverpool, district No. 3 | 639,034 | 352,397 | ..... | ..... | 991,431 |
| Geddes, district No. 4 | 764,871 | 1,503,730 | ..... | 351,600 | 2,620,201 |
| Total | 2,309,485 | 3,826,276 | 129,848 | 668,690 | 6,934,299 |

The gross revenue derived by the State for furnishing the brine, at the rate of 1 cent per bushel of salt produced, was $69,342.99. The surplus revenue above all expenditures leaves a profit to the State of $5,349.59. The following is a statement of the number of bushels of salt made at the Onondaga salt springs since June 20, 1797, the date of the first lease:

*Production of the Onondaga district* 1797 *to* 1885, *inclusive.*

[Bushels of 56 pounds.]

| Years. | Solar. | Fine. | Total. | Years. | Solar. | Fine. | Total. |
|---|---|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | | *Bushels.* | *Bushels.* | *Bushels.* |
| 1797 | | 25,474 | 25,474 | 1842 | 163,021 | 2,128,882 | 2,291,903 |
| 1798 | | 59,928 | 59,928 | 1843 | 318,105 | 2,809,395 | 3,127,500 |
| 1799 | | 42,704 | 42,704 | 1844 | 332,418 | 3,671,134 | 4,003,552 |
| 1800 | | 50,000 | 50,000 | 1845 | 353,455 | 3,408,903 | 3,762,358 |
| 1801 | | 62,000 | 62,000 | 1846 | 331,705 | 3,507,146 | 3,838,851 |
| 1802 | | 75,000 | 75,000 | 1847 | 262,879 | 3,688,476 | 3,951,355 |
| 1803 | | 90,000 | 90,000 | 1848 | 342,497 | 4,394,629 | 4,737,126 |
| 1804 | | 100,000 | 100,000 | 1849 | 377,735 | 4,705,834 | 5,083,569 |
| 1805 | | 154,071 | 154,071 | 1850 | 374,732 | 3,894,187 | 4,268,919 |
| 1806 | | 122,577 | 122,577 | 1851 | 378,967 | 4,235,150 | 4,614,117 |
| 1807 | | 175,448 | 175,448 | 1852 | 633,595 | 4,288,938 | 4,922,533 |
| 1808 | | 319,618 | 319,618 | 1853 | 577,947 | 4,826,577 | 5,404,524 |
| 1809 | | 128,282 | 128,282 | 1854 | 734,474 | 5,068,873 | 5,803,347 |
| 1810 | | 450,000 | 450,000 | 1855 | 498,124 | 5,584,761 | 6,082,885 |
| 1811 | | 200,000 | 200,000 | 1856 | 709,391 | 5,257,419 | 5,966,810 |
| 1812 | | 221,011 | 221,011 | 1857 | 481,280 | 3,830,846 | 4,312,126 |
| 1813 | | 226,000 | 226,000 | 1858 | 1,514,554 | 5,518,665 | 7,033,219 |
| 1814 | | 295,000 | 295,000 | 1859 | 1,345,022 | 6,549,250 | 6,894,272 |
| 1815 | | 322,058 | 322,058 | 1860 | 1,462,565 | 4,130,682 | 5,593,247 |
| 1816 | | 348,665 | 348,665 | 1861 | 1,884,697 | 5,315,694 | 7,200,391 |
| 1817 | | 408,665 | 408,665 | 1862 | 1,983,022 | 7,070,852 | 9,053,874 |
| 1818 | | 406,540 | 406,540 | 1863 | 1,437,656 | 6,504,727 | 7,942,383 |
| 1819 | | 548,374 | 548,374 | 1864 | 1,971,122 | 5,407,712 | 7,378,834 |
| 1820 | | 458,329 | 458,329 | 1865 | 1,886,760 | 4,499,170 | 6,385,930 |
| 1821 | | 526,049 | 526,049 | 1866 | 1,978,183 | 5,180,320 | 7,158,503 |
| 1822 | | 481,562 | 481,562 | 1867 | 2,271,892 | 5,323,673 | 7,595,565 |
| 1823 | | 726,988 | 726,988 | 1868 | 2,027,490 | 6,639,126 | 8,666,616 |
| 1824 | | 816,634 | 816,634 | 1869 | 1,857,942 | 6,804,295 | 8,662,237 |
| 1825 | | 757,203 | 757,203 | 1870 | 2,487,691 | 6,260,422 | 8,748,113 |
| 1826 | | 811,023 | 811,023 | 1871 | 2,464,464 | 5,910,492 | 8,374,956 |
| 1827 | | 983,410 | 983,410 | 1872 | 1,882,604 | 6,048,321 | 7,930,925 |
| 1828 | | 1,160,888 | 1,160,888 | 1873 | 1,691,359 | 5,768,998 | 7,460,357 |
| 1829 | | 1,129,280 | 1,129,280 | 1874 | 1,667,368 | 4,361,932 | 6,029,300 |
| 1830 | | 1,435,446 | 1,435,446 | 1875 | 2,655,955 | 4,523,491 | 7,179,446 |
| 1831 | | 1,514,037 | 1,514,037 | 1876 | 2,308,679 | 3,083,908 | 5,392,677 |
| 1832 | | 1,652,985 | 1,652,985 | 1877 | 2,525,335 | 3,902,648 | 6,427,983 |
| 1833 | | 1,838,646 | 1,838,646 | 1878 | 2,788,754 | 4,387,443 | 7,176,197 |
| 1834 | | 1,943,252 | 1,943,252 | 1879 | 2,957,744 | 5,364,418 | 8,322,162 |
| 1835 | | 1,209,867 | 1,209,867 | 1880 | 2,516,485 | 5,482,265 | 7,998,750 |
| 1836 | | 1,912,858 | 1,912,858 | 1881 | 3,011,461 | 4,905,775 | 7,917,236 |
| 1837 | | 2,167,287 | 2,167,287 | 1882 | 3,032,447 | 5,307,733 | 8,340,180 |
| 1838 | | 2,575,033 | 2,575,033 | 1883 | 2,444,374 | 5,053,057 | 7,497,431 |
| 1839 | | 2,864,718 | 2,864,718 | 1884 | 2,353,860 | 4,588,410 | 6,942,270 |
| 1840 | | 2,622,305 | 2,622,365 | 1885 | 2,439,332 | 4,494,967 | 6,934,299 |
| 1841 | 220,247 | 3,120,520 | 3,340,767 | | | | |

During 1885 ten new wells were drilled near Syracuse: six in the Salina district, three in the Gere group, and one in the Geddes group; while one of these proved a comparative failure, the other nine are unusually successful, furnishing a large supply of brine at an average strength of 77° by the salinometer. The cost of these wells was $13,096.65

The following table shows the strength of the brines in each district for each month in the season, as reported by Dr. F. E. Englehardt, State chemist:

*Strength of Onondaga brines for the year 1885.*

| Months. | Syracuse. | | Salina. | | Liverpool. | | Geddes. | |
|---|---|---|---|---|---|---|---|---|
| | Fahrenheit. | Salinometer. | Fahrenheit. | Salinometer. | Fahrenheit. | Salinometer. | Fahrenheit. | Salinometer. |
| | ° | ° | ° | ° | ° | ° | ° | ° |
| April | 55.50 | 71.18 | 56.00 | 74.40 | 56.00 | 74.40 | 55.00 | 70.29 |
| May | 56.66 | 69.28 | 55.33 | 72.70 | 55.33 | 72.70 | 56.00 | 70.70 |
| June | 57.66 | 66.83 | 56.33 | 69.33 | 56.33 | 69.33 | 58.00 | 69.21 |
| July | 57.50 | 66.38 | 57.50 | 68.70 | 57.50 | 68.70 | 59.00 | 66.76 |
| August | 55.80 | 67.72 | 56.75 | 70.64 | 56.75 | 70.64 | 55.80 | 69.17 |
| September | 54.80 | 67.07 | 56.60 | 70.43 | 56 60 | 70.43 | 56.40 | 70.46 |
| October | 52.50 | 67.00 | 53.50 | 72.32 | 53.50 | 72.32 | 53.50 | 70.74 |
| November | 52.00 | 69.41 | 53.00 | 72.93 | 53.00 | 72.93 | 53.33 | 72.06 |
| Total average | 55.38 | 68.09 | 55.63 | 71.43 | 55.63 | 71.43 | 55.88 | 69.67 |
| At 60° Fahr | ..... | 67.63 | ..... | 70.99 | ..... | 70.99 | ..... | 69.25 |

Grand total at 60° Fahr., 69.72° salinometer.

The average salinometer strength of the brines for the year 1885 shows a decrease of about one-half degree as compared with 1884. The Salina, Liverpool, and Geddes supply has been higher than that at Syracuse, the first two by 3½ degrees, and the Geddes by 1.6 degrees. This variation in strength of the four districts is partly due to the greater strengh of the Salina, Liverpool, and Geddes wells, and partly to the fact that when the greatest amount of brine is required by the salt works, these wells are unable to supply the required amount; hence the deficiency must be supplied from Syracuse, whereby the strength of the latter's wells naturally becomes reduced. The new wells drilled in 1885 will remedy this difficulty, and the average will be higher.

A table is appended showing the average strength of the brines in degrees of the salinometer (reduced to correspond with a temperature of 60° Fahr.) in the years from 1865 to 1885, inclusive, except 1868, for which year there are no records:

*Average strength of Onondaga brines.*

| Years. | Syracuse. | Salina. | Liverpool. | Geddes. | Average. |
|---|---|---|---|---|---|
| 1865 | 66.17 | 66.47 | 60.65 | 66.17 | 64.86 |
| 1866 | 65.90 | 65.81 | 58.34 | 65.90 | 63.98 |
| 1867 | 64.44 | 64.35 | 64.35 | 63.95 | 64.27 |
| 1869 | 60.98 | 60.36 | 60.36 | 59.02 | 62.88 |
| 1870 | 59.49 | 58.94 | 58.94 | 59.34 | 59 22 |
| 1871 | 63.00 | 62.35 | 62.35 | 63.82 | 62.88 |
| 1872 | 65.10 | 66.00 | 67.00 | 66.20 | 65.82 |
| 1873 | 63.43 | 65.33 | 65.43 | 67.52 | 65.45 |
| 1874 | 63.80 | 66.15 | 66.15 | 67.15 | 65.81 |
| 1875 | 63.88 | 66.38 | 66.38 | 69.50 | 66.54 |
| 1876 | 66.75 | 67.70 | 67.70 | 69.33 | 68.15 |
| 1877 | 68.94 | 69.19 | 69.19 | 69.59 | 69.26 |
| 1878 | 69.93 | 70.58 | 70.58 | 70.02 | 70.27 |
| 1879 | 66.61 | 67.47 | 67.47 | 67.16 | 67.20 |
| 1880 | 66.13 | 67.10 | 67.10 | 67.55 | 66.97 |
| 1881 | 67.02 | 66.68 | 66.68 | 68.21 | 67.36 |
| 1882 | 67.75 | 67.24 | 67.24 | 68.63 | 67.71 |
| 1883 | 66.67 | 68.30 | 68.30 | 69.34 | 68.15 |
| 1884 | 67.88 | 71.58 | 71.58 | 70.10 | 70.28 |
| 1885 | 67.63 | 70.99 | 70.99 | 69.25 | 69.72 |

The wells of the Warsaw district have increased to eight altogether, and interest in this part of the State has caused much prospecting to extend the territory under which the bed is known to exist. The most remarkable movement has been at Pifford station, Livingston county, where a shaft 1,200 feet deep has been sunk to a bed of rock salt which is to be mined as such. The layer is said to be 50 feet thick, and has been analyzed as follows:

*Analysis of rock salt from Livingston County, New York.*

| | Per cent. |
|---|---|
| Sodium chloride | 97.84 |
| Calcium sulphate | 1.04 |
| Moisture | .08 |
| Residue insoluble in water | .43 |
| Magnesium sulphate | Trace. |
| Loss | .61 |
| Total | 100.00 |

At Barker, 5 miles from Whitney's Point, Broome county, and at Clifton Springs, Ontario county, discoveries of rock salt were claimed, but the brines pumped from them were so weak as to lead to doubt as to the deposits.

*Ohio and West Virginia.*—The production decreased in both of these States in 1885, in spite of a slight advance in price to 65 cents per barrel.

*Estimated production of salt in Ohio, 1882 to 1885.*

| Years. | Barrels. | Value. |
|---|---|---|
| 1882 | 400,000 | $300,000 |
| 1883 | 350,000 | 231,000 |
| 1884 | 320,000 | 201,600 |
| 1885 | 306,847 | 199,450 |

*Estimated production of salt in West Virginia, 1882 to 1885, inclusive.*

| Years. | Barrels. | Value. |
|---|---|---|
| 1882 | 400,000 | $300,000 |
| 1883 | 320,000 | 211,200 |
| 1884 | 310,000 | 195,300 |
| 1885 | 223,184 | 145,070 |

*Louisiana.*—The production from the great mass of rock salt of Petite Anse, near New Iberia, increased during 1885; the total yield of various grades was 41,898 short tons, valued at $139,911. The following table shows the varieties of salt made since 1882:

*Production of the Petite Anse mine in* 1882, 1883, 1884, *and* 1885.

| Grades. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|
| | *Short tons.* | *Short tons.* | *Short tons.* | *Short tons.* |
| Lump | 20 | 405 | 1,485 | 3,267 |
| Crushed | 5,995 | 10,595 | 7,550 | 11,038 |
| Coarse | 16,595 | 22,480 | 15,750 | 20,585 |
| Fine | 2,940 | 3,625 | 6,280 | 6,958 |
| Table | | 25 | 290 | 50 |
| Total | 25,550 | 37,130 | 31,355 | 41,898 |

The average price of lump salt was $5 per ton and the others $2.75. The demand for this salt increases, particularly from packers of meat who prefer it to Turk's Island or Mediterranean salt, on account of its its greater purity. The finer grades of ground salt have been improved by screens which remove the dust, and thus make the salt less liable to cake, which has been an objection. During 1885 a shaft was sunk 70 feet below the floor of the old workings; the salt obtained does not differ in quality from that above.

## PACIFIC COAST.

The consumption of salt on the Pacific coast, owing to a somewhat lessened demand for metallurgical purposes, has not been so large during the past two or three years as formerly. The greatest decrease in consumption has occurred probably in Nevada and Arizona.

*California.*—The manufacture of salt has suffered little or no diminution in California, resulting in lower prices and an accumulation of stocks. Most of the salt produced in this State continues to be made at the extensive works located on the eastern shore of the San Francisco bay, where the manufacture is effected wholly by the process of solar evaporation.

The quantity of salt made in California during the past six years has been as follows, the amount made in excess of receipts at San Francisco being estimated:

*Production in California,* 1880 *to* 1885.

| Years. | Short tons. |
|---|---|
| 1880 | 14,000 |
| 1881 | 17,000 |
| 1882 | 19,000 |
| 1883 | 30,000 |
| 1884 | 25,000 |
| 1885 | 31,000 |

The season of active operations, which usually extends from about the 1st of May to the middle of November, was much shortened in 1884, by reason of long continued spring rains, and the output of the Bay Salt Works was considerably less in that year than it otherwise would have been. The working season in 1885 was long and otherwise favorable, and the production large, amounting to fully 25,000 tons in San Francisco. While a variety of improvements have been introduced at these works during the past year, their productive capacity has undergone little or no enlargement, the low prices ruling for salt of late having discouraged efforts in that direction. The prices of salt have not been so low in San Francisco for several years. Liverpool salt averaged throughout the year 1885 not more than $14 per ton, the year closing at about that figure, with large stocks on hand.

The imports of salt at the port of San Francisco during the past five years have been as follows:

*Imports of salt at San Franscisco.*

| | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds* | *Pounds.* | *Pounds.* |
| English | 13, 828, 066 | 7, 745, 468 | 12, 841, 212 | 8, 543, 878 | 8, 500, 000 | 13, 200, 320 |
| Carmen Island | 3, 542, 000 | 2, 730, 000 | 761, 600 | 21, 046 | 15, 000 | ..... |
| Peru | ..... | ..... | 1, 200, 000 | ..... | ..... | ..... |
| Total | 17, 370, 066 | 10, 475, 468 | 14, 802, 812 | 8, 564, 924 | 8, 515, 000 | 13, 200, 320 |

The exports of salt from San Francisco amount to several thousand tons per year. The most of this is sent to Oregon, Washington Territory, and British Columbia, with small lots to Mexico and the Sandwich Islands.

It is not profitable to export salt to Australia, owing to a duty of $10 per ton being imposed by the several colonial goverments. Some small shipments made to New Zealand, where it is admitted duty free, have, however, proved remunerative. The quality of the salt produced in California improves every year, and much of that now made is considered equal to the best imported.

The Liverpool Salt Company, a California corporation, which opened a new saline on the Colorado desert in 1884, producing that year 1,500 tons of salt, has since more than doubled its output, having in the mean time put up a mill for grinding salt for table and other domestic uses. This mill, which is driven by steam and has a capacity to grind 25 tons per day, is located at Salton, the nearest station and shipping point on the Southern Pacific railroad. It is connected with the salt bed, 2 miles distant, by rail. Salton is 6½ miles to the west of Dos Palmas, a former station on the railroad, which has been discontinued. The summer climate here is excessively hot, the temperature for six or seven months in the year averaging over 100° during the day in the shade and rising often as high as 140° in the sun. The atmos-

phere is at the same time exceedingly dry, the annual rainfall amounting to not more than 4 or 5 inches; evaporation goes on with great rapidity, rendering the production of salt by the process here in use an easy matter. The water supplied to the mill, being brought for a distance of less than a mile, through iron pipes laid on top of the ground, becomes so hot that it is injected into the boiler at quite an elevated temperature.

The salt at this place occurs in the form of a crust, 1 foot or more thick, resting on a shallow lake of brine. This crust, which is covered with a thin coating of drift sand and dust, is cut away in longitudinal sections and, falling into the water below, is cleansed of the impurities that adhere to it. After this, having been thrown on a platform and left till the water drains off, this salt is ready to be taken to the mill for grinding, or to be sacked and sent to market. Over these open places a new crust at once commences to form, and the salt, crystallizing from the water below, soon fills them up again. The salt obtained here, even in its natural condition, is remarkably pure, an analysis recently made giving the following results:

*Analysis of salt from Dos Palmas, California.*

| | Per cent. |
|---|---|
| Chloride of sodium | 97.76 |
| Sulphate of sodium | .70 |
| Chloride of calcium | .27 |
| Moisture | .96 |
| Insoluble matter | .20 |
| Total | 99.89 |

This company is now supplying salt to the southern counties of California and a large portion of Arizona. It also commenced shipping small lots last year into the northwestern parts of Mexico, but this was checked soon after by the Mexican Government raising the duty on imported salt from $5 to $10 per ton, a duty which the company could not afford to pay. What has enabled this company to supply such a large extent of territory has been the low freights at which the Southern Pacific railroad has carried the product of the works. On that road this salt goes as far east as El Paso, and north to the Tulare country.

During the past year a heavy and what promises to be a valuable bed of salt was discovered in the northeastern part of San Bernardino county. It lies in a dry valley about 6 miles from the south end of Old Woman mountain and about 25 miles in a southeasterly direction from Danby station on the Atlantic and Pacific railroad, from which there is a wagon road to the salt deposit. The salt occurs here in strata, each about 2 feet thick, separated from each other by a seam of clay half an inch thick. The deposit, which has been opened to a depth of 10 feet, and from which 200 tons of clean and nearly pure crystallized salt have been taken, covers, so far as traced, an area of some 40 acres, though it

is supposed to be much larger, being covered with a thin layer of drift sand and dust. It is probable that the mines in this part of San Bernardino county, and as far west as the Calico district, and also the northern parts of Arizona, will ultimately be supplied with salt from this source.

Salt is still made in considerable quantity from the well bored some two years ago near the town of Yreka, Siskiyou county. An excellent article is produced by the method of graduation here in use. The manufacture of salt at this point has been found profitable, by reason of a very considerable local demand, and on account of the cost of transportation from other producing or supplying localities. Salt in small quantities continues to be made also at several other places in California, only enough being produced to meet the wants of the immediate neighborhood.

*Nevada.*—In the other States and Territories lying west of the Rocky mountains no important changes have taken place in the salt industry during the past year, either as regards new discoveries or quantity made. In Nevada small lots have been taken from the numerous salines scattered over that State, the most of it for beneficiating the silver bearing ores, not more than a few hundred tons having been refined at the several works formerly erected there. For the year the total production in the State has not exceeded 4,000 short tons; the prospect for the incoming year indicates a slight increase.

*Arizona.*—While the domestic consumption in Arizona has been about the same, the demand for the ore reduction works was less last year than for several preceding years. The most notable salines in this Territory consist of the several lagoons situated in Apache county near the New Mexican line, and from one of which about 500 tons of crystallized salt of good quality are shoveled up and carried away every year. This salt contains a small percentage of saltpeter, an addition which is said to improve it for meat packing. The present consumption of Arizona may be set down at about 3,500 tons per year.

*Utah.*—In Utah about 15,000 tons of salt, the average quantity of late years, was produced, the most of it by solar evaporation, from the water of Great Salt Lake. More than half the salt made here is sent to Nevada, Colorado, Idaho, and Montana, to be used in ore reduction, for which it answers very well despite the considerable amount of dust and sand which, blowing into the evaporating basins, become mixed with it while it is being made. This salt can be produced and loaded on the cars, after hauling it 6 miles, at the rate of $5 per short ton. The shipments of Utah salt to Montana fell off heavily last year, several of the mills at Butte City having shut down in consequence of the high freight—$20 per ton—charged for its transportation over the Utah and Northern railroad, the mining companies claiming that they could not mill their ores with any profit with such transportation charges on salt. For the past three or four years the ores about Butte have been

growing steadily poorer and at the same time baser. On an average they yield now not over 35 ounces of silver per ton, while they require from 12 to 15 per cent. salt for successful treatment. Though they have plenty of ore of this grade, it is not available, so the miners contend, with salt at $25 per ton.

*Idaho.*—The Oneida Company produced last year at their works in southeastern Idaho about 800 tons of salt, for a portion of which a market was found in the neighborhood, the bulk of it being consumed in the mines of Idaho and Montana. At the above point, numerous salt springs occur, the water from which is evaporated by artificial heat. Oregon and Washington Territory obtain their supply of salt from California, a little being made in the former from the brine of salt springs.

*Imports and exports.*—The imports of salt into the United States since 1867 and the exports from this country since 1790 have been carried forward from the last report and are shown in the following tables. While the quantities are doubtless given correctly, there are apparent discrepancies in the values as reported:

*Salt imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Cake, over 30 per cent. of potash. | | In bags, barrels, and other packages. | | In bulk. | | For the purpose of curing fish. | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| 1867 | ..... | ..... | 254,470,862 | $698,570 | 229,304,323 | $336,302 | ..... | ..... | $1,032,872 |
| 1868 | ..... | ..... | 308,446,080 | 915,546 | 219,975,096 | 365,458 | ..... | ..... | 1,281,004 |
| 1869 | ..... | $1,752 | 297,382,750 | 895,272 | 256,765,240 | 351,168 | ..... | ..... | 1,248,192 |
| 1870 | ..... | 9,698 | 288,479,287 | 797.194 | 349,776,433 | 507,874 | 68,597,023 | $87,048 | 1,401,814 |
| 1871 | ..... | 2,436 | 283,993,799 | 800,454 | 274,730,573 | 355,318 | 64,671,139 | 66,008 | 1,224,216 |
| 1872 | ..... | ..... | 258,252,807 | 788,893 | 257,637,230 | 312,569 | 57,830,929 | 60,155 | 1,161,617 |
| 1873 | ..... | ..... | 239,494,117 | 1,254,818 | 368,012,142 | 525,585 | 86,756,628 | 86,193 | 1,866,596 |
| 1874 | ..... | ..... | 358,375,496 | 1,452,161 | 427,294,209 | 649,838 | 105,613,913 | 126,896 | 2,228,895 |
| 1875 | ..... | 1,867 | 318,673,091 | 1,200,541 | 401,270,315 | 549,111 | 110,249,440 | 119.607 | 1,871,126 |
| 1876 | ..... | ..... | 331,266,140 | 1,153,480 | 379,478,218 | 462,106 | 118,760,638 | 126,276 | 1,741,862 |
| 1877 | ..... | ..... | 359,005,742 | 1,059,941 | 444.044,370 | 532,831 | 122,433.972 | 140,787 | 1,733,559 |
| 1878 | ..... | ..... | 352,109,963 | 1,062,995 | 414,813,516 | 483,909 | 100,794.611 | 96,898 | 1,643,802 |
| 1879 | ..... | 2,480 | 375,286,472 | 1,150,018 | 434,760,132 | 532.706 | 94,060,114 | 95,841 | 1,781,045 |
| 1880 | ..... | 21,667 | 400,970,531 | 1,180,082 | 449,743,872 | 548,425 | 109.024,446 | 119,667 | 1,869,841 |
| 1881 | 1,397,579 | 8,187 | 412.442,291 | 1,242,543 | 529,361,042 | 658,068 | 133,395,065 | 144,347 | 2,053,145 |
| 1882 | 8,954,834 | 55,622 | 329,969,300 | 1,086,932 | 399,100.228 | 474,200 | 124,777,569 | 147,058 | 1,763,812 |
| 1883 | 7,863,756 | 43,363 | 312,911,360 | 1,035,946 | 412,938,686 | 451,001 | 142,065,557 | 154,671 | 1,684,981 |
| 1884 | (*a*)8,416,147 | 40,646 | 340,759,010 | 1,093,628 | 441,613,517 | 433,827 | 126,605,276 | 122,463 | 1,690,564 |
| 1885 | (*a*)11,614,534 | 52,334 | 351,276,969 | 1,030,029 | 412,322,341 | 386,858 | 140,067,018 | 121,429 | 1,590,650 |

*a* Classed as "salt cake;" amount of potash not specified.

*Salt, of domestic production, exported from the United States.*

| Fiscal years ending September 30 until 1842, and June 30 since— | Quantity. | Value. | Fiscal years ending September 30 until 1842, and June 30 since— | Quantity. | Value. |
|---|---|---|---|---|---|
| | *Bushels.* | | | *Bushels.* | |
| 1790 | 31,935 | $8,236 | 1857 | 576,151 | $190,699 |
| 1791 | 4,208 | 1,052 | 1858 | 533,100 | 162,650 |
| 1830 | 47,488 | 22,978 | 1859 | 717,257 | 212,710 |
| 1831 | 45,847 | 26,848 | 1860 | 475,445 | 129,717 |
| 1832 | 45,072 | 27,914 | 1861 | 537,401 | 144,046 |
| 1833 | 25,069 | 18,211 | 1862 | 39[illegible],506 | 228,109 |
| 1834 | 89,064 | 54,007 | 1863 | 584,901 | 277,838 |
| 1835 | 126,230 | 46,483 | 1864 | 635,519 | 296,088 |
| 1836 | 49,917 | 31,943 | 1865 | 589,537 | 358,109 |
| 1837 | 99,133 | 58,472 | 1866 | 670,644 | 390,980 |
| 1838 | 114,155 | 67,707 | 1867 | 605,825 | 304,030 |
| 1839 | 264,337 | 64,272 | 1868 | 624,970 | 289,936 |
| 1840 | 92,145 | 42,246 | 1869 | 442,947 | 190,076 |
| 1841 | 215,084 | 62,765 | 1870 | 298,142 | 119,582 |
| 1842 | 110,400 | 39,064 | 1871 | 120,156 | 47,115 |
| 1843 (nine months) | 40,678 | 10,262 | 1872 | 42,603 | 19,978 |
| 1844 | 157,529 | 47,755 | 1873 | 73,323 | 43,777 |
| 1845 | 131,500 | 45,151 | 1874 | 31,657 | 14,701 |
| 1846 | 117,627 | 30,520 | 1875 | 47,094 | 16,273 |
| 1847 | 202,244 | 42,333 | 1876 | 51,014 | 18,378 |
| 1848 | 219,145 | 73,274 | 1877 | 65,771 | 20,133 |
| 1849 | 312,063 | 82,972 | 1878 | 72,427 | 24,968 |
| 1850 | 319,175 | 75,103 | 1879 | 43,710 | 13,612 |
| 1851 | 344,061 | 61,424 | 1880 | 22,179 | 6,613 |
| 1852 | 1,467,676 | 89,316 | 1881 | 45,455 | 14,752 |
| 1853 | 515,857 | 119,729 | 1882 | 42,085 | 18,265 |
| 1854 | 548,185 | 159,026 | 1883 | 54,147 | 17,321 |
| 1855 | 536,073 | 156,879 | 1884 | 70,014 | 26,007 |
| 1856 | 698,458 | 311,495 | 1885 | (*a*)4,101,587 | 26,488 |

*a* Pounds.

# BROMINE.

By David T. Day.

*Present state of the industry.*—The principal development of the bromine industry during the past year has been at the Michigan salt wells, and in western Pennsylvania. Until very recently the attempts to make bromine from the Michigan brines were unsuccessful, bromides being present in only very slight traces. At Midland, in Midland county, Michigan, an isolated system of wells yields bittern containing 4.2 per cent. of bromine, according to the analysis of Mr. Ayres, of the University of Michigan. This bittern is now worked and produces about one eighth of the United States supply. It is a singular fact that brines in Saginaw, only 25 miles distant, yield scarcely a trace of bromine. This new development in Michigan has peculiar significance inasmuch as the monopoly in the production of bromine which West Virginia and Ohio have hitherto enjoyed has aided those regions in their competition with the Michigan salt industry. Bromine has been a valuable by-product in the manufacture of salt; and if enough is found in Michigan to supply the trade it will be a severe blow to the salt works on the Ohio river.

The method of manufacture of bromine in Michigan is different from the common process in West Virginia and elsewhere. The conditions are different in Michigan, and they seem best met by the use of potassium chlorate as an oxidizing agent in place of manganese dioxide, which is in general use on the Ohio river. As the former substance is made with chlorine, which in turn is made by the oxidizing effect of manganese dioxide, it would seem that oxidation by potassium chlorate is in the end only a repetition of the effect of manganese dioxide, and that it would be a direct saving of labor and of the inevitable waste in producing potassium chlorate if manganese dioxide were used to oxidize the hydrobromic acid which is the product of treating bittern with sulphuric acid; and doubtless this would be true were it not for the fact that bromides form only a small part of the Michigan bittern. It contains also much calcium chloride. This substance causes such inconvenient precipitates of calcium sulphate, with sulphuric acid, that it becomes desirable to use the minimum quantity of that acid. This is best effected by using potassium chlorate, with which less than half as much sulphuric acid is necessary as with manganese dioxide. This point in favor of potassium chlorate is declared sufficient to justify its use when selling at, or below, 17 cents per pound, and its use is spreading to

those wells in West Virginia in which calcium chloride is found in unusual quantity.

In western Pennsylvania the salt wells at Tarentum have been yielding bromine for some time. In Allegheny three firms are now producing bromine.

In West Virginia and Ohio, the bromine industry is suffering from the depression in the salt trade brought about by the Michigan industry. At Charleston, West Virginia, for instance, out of forty-five salt furnaces in operation forty years ago, only one remains, and that has been disabled by the recent freshets in the Kanawha river. The greater part of the bromine is, however, still produced in West Virginia and Ohio. The proportion of bromides to salt in the Pomeroy region is now such as to yield 1 pound of bromine for 2 barrels of salt.

*Production.*—The amount of bromine produced during 1885 was slightly greater than the product of 1884, being about 310,000 pounds, of which 110,000 pounds were made in the Pomeroy region; 15,000 pounds in the Tuscarawas valley, Ohio; 85,000 in West Virginia; 60,000 in Pennsylvania, and 40,000 in Michigan. The following table gives the production of bromine during the last three years:

*Production of bromine in the United States, 1883, 1884, and 1885.*

| Source. | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Pounds.* |
| Pomeroy, Ohio | 171,116 | 159,881 | 110,000 |
| Tuscarawas valley, Ohio | 23,334 | 21,710 | 15,000 |
| West Virginia | 106,650 | 99,509 | 85,000 |
| Pennsylvania | ..... | ..... | 60,000 |
| Michigan | ..... | ..... | 40,000 |
| Total | 301,100 | 281,100 | 310,000 |

*Price.*—Early in 1885 a combination was effected among nearly all the producers of bromine throughout the United States; the product was pooled and sold through the agency of Mr. D. G. Hildt, of New Philadelphia, Ohio. Owing to this combination the price rose steadily from about 25 cents per pound to 30 cents in April, and to 33 cents before the close of the year, with a promise of higher prices. The greater part was sold to manufacturers of bromides in Philadelphia and Boston, and a small portion was exported to France.

# IODINE.

By David T. Day.

The iodine imported during 1885 amounted to 238,994 pounds, valued at $310,015. This is called "crude iodine." A trifling amount of "resublimed" iodine was also imported, amounting to only 4 pounds, valued at $16. The importations from 1867 to 1885, inclusive, are given below.

*Iodine imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Crude. | | Resublimed. | | Iodine salts. | Total. |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | | |
| | *Pounds.* | | *Pounds.* | | | |
| 1867 | 12,347 | $28,013 | 3,199 | $6,764 | ..... | $34,777 |
| 1868 | 18,994 | 55,869 | 5,527 | 16,178 | ..... | 72,047 |
| 1869 | 17,241 | 50,625 | 5,882 | 18,356 | $3,589 | 72,570 |
| 1870 | 27,825 | 70,777 | 2,233 | 6,251 | ..... | 77,028 |
| 1871 | 74,320 | 212,195 | 956 | 3,499 | ..... | 215,694 |
| 1872 | 81,437 | 292,998 | 258 | 2,166 | 41 | 295,205 |
| 1873 | 48,991 | 206,783 | 10 | 87 | ..... | 206,870 |
| 1874 | 23,861 | 89,305 | 2 | 16 | ..... | 89,321 |
| 1875 | 26,058 | 74,357 | 54 | 171 | 3 | 74,531 |
| 1876 | 24,913 | 55,443 | ..... | ..... | ..... | 55,443 |
| 1877 | 50,123 | 111,494 | ..... | ..... | ..... | 111,494 |
| 1878 | 73,687 | 230,041 | ..... | ..... | 12 | 230,053 |
| 1879 | 31,779 | 122,571 | ..... | ..... | ..... | 122,571 |
| 1880 | 104,703 | 501,957 | 2 | 12 | ..... | 501,969 |
| 1881 | 162,863 | 336,998 | 13 | 30 | 648 | 337,676 |
| 1882 | 119,952 | 213,311 | 15 | 28 | 1,266 | 214,605 |
| 1883 | 140,642 | 162,036 | 5 | 8 | 5,972 | 168,016 |
| 1884 | 153,550 | 173,234 | 336 | 493 | (*a*) | 173,744 |
| 1885 | 238,994 | 310,015 | 4 | 16 | (*a*) | 310,031 |

*a* Not specified.

The iodine thus imported comes principally from Chili and Peru, the production in Scotland having declined considerably. It is not possible to find the exact proportion of South American iodine to that from Great Britain. It is quite nearly represented, however, in the following table, in which are given the receipts in New York from South America direct and those from European ports. Some of the latter may be re-shipments of South American iodine.

*Receipts of iodine at New York.*

| Years. | From South America. | From Hamburg, London, and ports other than South America. |
|---|---|---|
| | *Kegs.* | *Packages.* |
| 1883 | 414 | 28 |
| 1884 | 1,138 | 165 |
| 1885 | 981 | 24 |

The production of iodine in South America has grown steadily. A table in the last report gave the estimated annual yield; this has been replaced by the following table containing the exact shipments from Iquique, from 1881 to 1885, inclusive, with estimates for previous years. These have been obtained from Messrs. Gehe & Co., of Dresden, through the courtesy of Messrs. Powers & Weightman.

*Production of iodine in South America.*

| Years. | Pounds. | Years. | Pounds. |
|---|---|---|---|
| 1873 | 30,000 | 1880 | 380,000 |
| 1874 | 100,000 | 1881 | 308,700 |
| 1875 | (a)100,000 | 1882 | 453,789 |
| 1876 | 110,000 | 1883 | 421,984 |
| 1877 | 200,000 | 1884 | 526,459 |
| 1878 | 280,000 | 1885 | 529,200 |
| 1879 | 350,000 | | |

a From 131 manufactories.

*The Scotch iodine industry.*—It is needless to say that strenuous efforts have been made by those interested in the utilization of Scotch and Irish seaweed to keep pace with South American progress. At the International Inventions Exhibition in London in this last year, Mr. E. C. C. Stanford, of Glasgow, gave an interesting exhibition of the iodine industry as developed in Scotland. This included the various processes that have been suggested to prevent waste in burning the seaweed. Mr. Stanford has introduced many of these improvements, notably the "char process," in which the weed is submitted to destructive distillation in iron retorts, leaving behind a loose porous charcoal containing the salts and iodine, and yielding in the distillate, ammonia, acetic acid, and tar. In a still later process, he proposed to extract first the potassium chloride ("muriates"), potassium sulphate, and "kelp salt" (sodium chloride containing some sodium carbonate and including the iodides) by simple maceration in cold water. The amount so removed from air-dried Laminaria is about one-third of its weight, of which 20 to 22 per cent. consists of mineral salts, and the balance of dextrine, mannite, and extractive matter, leaving two-thirds of the plant for further treatment. The residue contains a peculiar new substance called "algin," and cellulose. This algin resembles albumen, but is distinguished by not coagulating on heating. It is proposed to use it for sizing fabrics, as a mordant in dyeing and printing, as an article of food in place of gelatine, and, when pressed with cellulose, as a basis for artificial wood. Its separation from cellulose caused the following modification of the process: The freshly dried seaweed is boiled with sodium carbonate, the solution filtered and treated with sulphuric acid; this precipitates the algin. The solution is next neutralized with limestone, filtered from the resulting gypsum, and evaporated until sodium sulphate crystallizes out. The mother liquor containing all the potassium salts and iodine is carbonized, forming "kelp substitute," from which iodine is obtained in the ordinary

way. The relative economy of the old process, the char process, and the "wet process," as this last improvement is called, may be compared in the following scheme:

*Kelp (or native) process.*

100 tons dry seaweed yield 18 tons of kelp, containing—
- 9 tons of potassium and sodium salts.
- 270 pounds iodine.
- 10 tons waste salts and loss.

*Distillation process ("char" process).*

100 tons dry seaweed yield
- 36 tons charred residue, containing
  - 15 tons of potassium and sodium salts.
  - 600 pounds iodine.
  - 20 tons charcoal.
- Acetic acid.
- Ammonium acetate.
- Tar.

*Wet process*

100 tons dry seaweed yield
- 33 tons water extract, containing
  - 20 tons of potassium and sodium salts.
  - 600 pounds iodine, dextrine, etc.
- 20 tons algin.
- 15 tons cellulose.

*Price.*—The combination among producers has kept the price of crude iodine quite uniformly at 9 pence per ounce, or $2.88 per pound, during 1885. The only variations from this figure were caused by irregular sales of iodine in second hands at from 8⅜ to 8⅞ pence per ounce. With the increasing production it does not seem possible for the price to keep its present place, even with the help of the combination. The following table gives the price of iodine since it first became an article of commerce:

*Kelp imports into the Clyde, and price of iodine.*

| Years ending June 30— | Kelp imports. | Price of iodine. | Years ending June 30— | Kelp imports. | Price of iodine. |
|---|---|---|---|---|---|
| | *Long tons.* | *Per pound.* | | *Long tons.* | *Per pound.* |
| 1841 | 2,565 | $1.20 | 1866 | 8,858 | $2.40 |
| 1842 | 1,887 | 1.12 | 1867 | 8,174 | 2.88 |
| 1843 | 1,965 | 1.44 | 1868 | 8,116 | 3.04 |
| 1844 | 3,263 | 2.88 | 1869 | 8,978 | 3.12 |
| 1845 | 6,086 | 7.46 | 1870 | 9,257 | 3.04 |
| 1846 | 3,627 | 5.34 | 1871 | 9,384 | 3.44 |
| 1847 | 4,000 | 2.64 | 1872 | 10,049 | 8.16 |
| 1848 | 4,400 | 2.64 | 1873 | 9,449 | 5.12 |
| 1849 | 4,731 | 2.64 | 1874 | 10,923 | (*a*)3.52 |
| 1850 | 11,421 | 2.56 | | | (*b*)2.94 |
| 1851 | 7,320 | 2.08 | 1875 | 8,643 | (*a*)2.44 |
| 1852 | 5,418 | 3.64 | | | (*b*)2.25 |
| 1853 | 6,491 | 3.72 | 1876 | | (*a*)1.92 |
| 1854 | 4,679 | 2.88 | | | (*b*)1.87 |
| 1855 | 5,826 | 3.20 | 1877 | | (*c*)3.28 |
| 1856 | 6,349 | 3.28 | 1878 | | (*c*)4.00 |
| 1857 | 8,641 | 2.96 | 1879 | | (*c*)4.48 |
| 1858 | 8,123 | 2.52 | 1880 | | (*d*)1.92 |
| 1859 | 8,190 | 2.32 | 1881 | | (*d*)2.00 |
| 1860 | 7,754 | 2.04 | 1882 | | (*d*)1.60 |
| 1861 | 9,722 | 1.68 | 1883 | | (*d*)1.28 |
| 1862 | 9,414 | 1.36 | 1884 | | (*d*)1.20 |
| 1863 | 14,018 | 1.20 | | | (*e*)2.88 |
| 1864 | 11,349 | 2.00 | 1885 | | (*e*)2.88 |
| 1865 | 13,741 | 1.84 | | | |

*a* Scotch. *b* Peruvian. *c* Combination. *d* Combination broken. *e* Recombination.

# BORAX.

*California and Nevada.*—These are the only States that produce any borax, and the only ones on the western Continent that produce salts of boracic acid steadily and in considerable quantity. For several years past the production of borax in these two States has afforded the manufacturer but little profit, owing to the extremely low prices which have ruled in the leading markets of the world. Commercial borax, which sold in San Francisco less than four years ago at 11 cents per pound for concentrated and 13 cents per pound for the refined salt, is selling there now for 6 and 8 cents per pound respectively. The causes for this unexampled depression in price having been sufficiently explained in previous reports of this series, need be stated here only in general terms. Prominent among these causes are overproduction, rivalry between companies competing for the market, and overestimates of the California and Nevada resources, to which may be added a strange misapprehension shown at times in regard to the future of the trade. The industry having outlived these disturbing features, appears to have settled finally to a more certain and stable basis. Under these more normal conditions the trade will be likely to fluctuate less both as regards production and prices hereafter, and will prove in general more satisfactory to the manufacturer. Meantime, the home and foreign producers have been brought into greater harmony with each other, and will no doubt find it to their interest to act concertedly.

With the prevailing low prices the consumption of borax is evidently increasing in the various arts and manufactures in which it has been employed, while new uses are continually being found for it. In this extended consumption manufacturers will, no doubt, find some compensation for the present low prices. Once introduced, the price may be advanced without diminishing its use markedly. It is probable that the present output of the California and Nevada companies now in the field will be kept up, and may even be slightly increased for some time to come. It is not at all likely, however, that any of the unimproved salines in these States, of which there are several, will be utilized at once, there being nothing to encourage further investments in the business at present. Only the practice of the strictest economy has enabled existing companies to continue operations till the present time.

The annual production of borax on the Pacific coast during the past ten years has been approximately as follows:

*Production of borax.*

| Years. | Pounds. |
|---|---|
| 1876 | 5,180,810 |
| 1877 | 3,727,280 |
| 1878 | 2,802,800 |
| 1879 | 1,584,966 |
| 1880 | 3,860,748 |
| 1881 | 4,045,405 |
| 1882 | 4,236,291 |
| 1883 | 6,500,000 |
| 1884 | 7,000,000 |
| 1885 | 8,000,000 |

It should be stated that the above figures, while they cannot be far out of the way, are not absolutely correct. There being no official record of the quantity of borax made annually by the several companies engaged in the business, round numbers have latterly been adopted in estimating the same. The employment of more precise figures has been found impracticable on account of the practice of individuals and small companies in the borate fields of making a few tons of borax and selling it to the local merchants, who in turn dispose of it directly to buyers and consumers in San Francisco. None of these parties keep any account of the small lots so handled.

*Shipments of borax from California and Nevada in* 1883, 1884, *and* 1885.

| To— | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Pounds.* |
| East by rail | 3,288,200 | 2,995,880 | 1,500,000 |
| New York by sea | 1,911,116 | 3,446,326 | 5,081,557 |
| Liverpool | 1,287,777 | 740,291 | 2,312,827 |
| China | 20,231 | 33,862 | 28,656 |
| Japan | 8,882 | 3,327 | 20,498 |
| Victoria | 1,200 | 2,487 | ..... |
| Mexico | 6,301 | 3,555 | 7,916 |
| Honolulu | 4,200 | 475 | 120 |
| Australia | 820 | 21,542 | 29,589 |
| Central America | ..... | 200 | 600 |
| Antwerp | ..... | 22,500 | ..... |
| British Columbia | ..... | ..... | 807 |
| France | ..... | ..... | 23,630 |
| Total | 6,528,727 | 7,270,445 | 9,006,200 |

*Borax, boracic acid, and borate of lime imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Refined borax. | | Crude borax. | | Boracic acid. | | Borate of lime. | | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Pounds.* | | *Pounds.* | | *Pounds.* | | *Pounds.* | | |
| 1867 | 49,652 | $6,601 | 5,672 | $711 | 770,756 | $73,396 | ..... | ..... | $80,708 |
| 1868 | 79,183 | 10,127 | 22,293 | 2,985 | 243,993 | 22,845 | ..... | ..... | 35,957 |
| 1869 | 89,695 | 12,799 | 54,822 | 8,011 | 988,033 | 109,974 | ..... | ..... | 130,784 |
| 1870 | 97,078 | 14,511 | 2,616 | 322 | 1,166,145 | 173,806 | 33,529 | $1,666 | 190,305 |
| 1871 | 134,927 | 20,705 | 5 | 1 | 1,204,049 | 185,477 | 45,600 | 2,248 | 208,431 |
| 1872 | 35,542 | 6,288 | ..... | ..... | 1,103,974 | 191,575 | 22,500 | 800 | 198,663 |
| 1873 | 9,284 | 2,152 | ..... | ..... | 1,222,006 | 255,186 | ..... | ..... | 257,338 |
| 1874 | 3,860 | 1,253 | 588 | 78 | 233,955 | 52,752 | ..... | ..... | 54,083 |
| 1875 | 5,153 | 1,224 | ..... | ..... | 41,742 | 6,280 | ..... | ..... | 7,504 |
| 1876 | 3,145 | 691 | ..... | ..... | 137,518 | 15,711 | ..... | ..... | 16,402 |
| 1877 | 3,500 | 676 | 55 | 12 | 107,468 | 11,231 | ..... | ..... | 11,919 |
| 1878 | 3,492 | 514 | 286 | 61 | 178,798 | 14,925 | ..... | ..... | 15,500 |
| 1879 | 3,472 | 490 | ..... | ..... | 306,462 | 21,888 | ..... | ..... | 22,378 |
| 1880 | 15,278 | 2,011 | ..... | ..... | 243,733 | 18,473 | 22,122 | 742 | 21,226 |
| 1881 | 4,136 | 865 | ..... | ..... | 187,053 | 15,771 | ..... | ..... | 16,636 |
| 1882 | 15,710 | 3,774 | ..... | ..... | 536,334 | 71,343 | ..... | ..... | 75,117 |
| 1883 | 5,611 | 1,359 | ..... | ..... | 4,334,432 | 580,171 | ..... | ..... | 581,530 |
| 1884 | 7,332 | 1,691 | 142 | 34 | 44,512 | 4,494 | ..... | ..... | 6,219 |
| 1885 | 240 | 41 | ..... | ..... | 48,517 | 4,035 | ..... | ..... | 4,076 |

*Imports of boracic acid in* 1884 *and* 1885.

| | 1884. | | 1885. | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| Commercial | 42,900 | $4,193 | 42,165 | $3,208 |
| Pure | 1,611 | 301 | 6,352 | 827 |

# SULPHUR.

By William C. Day.

Since the publication of the last report, 1883 and 1884, the most important advance in connection with the sulphur industry in this country is the result of the operations upon the deposits at Cove Creek Fort, Millard county, Utah. These deposits were described in the last report, and the fact was stated that a considerable amount of money had been invested for the purpose of extracting and refining crude sulphur. A company known as the Dickert & Myers Sulphur Company, of which Mr. Daniel Myers, of Cleveland, is president, has been incorporated with a capital stock of $2,000,000.

In 1870 Mr. Ferdinand Dickert, secretary, treasurer, and general manager of this company, visited Sicily for the purpose of examining the sulphur mines and the methods employed to extract and refine sulphur, as well as to determine the nature and extent of the competition to which similar operations upon American sulphur would be subjected. Mr. Dickert has recently taken out United States patents on improvements in the steam process of extraction which he found employed with only indifferent success at mines near Palermo in 1871. He has also patented improvements on the chloride of calcium process. As a result of this preliminary investigation on the part of its general manager the company is well prepared to compete with the introduction of foreign sulphur.

About two years ago operations upon the claim known as the Cleveland were begun, and have been continued with few and short interruptions to the present. The process of extraction now used at this claim is as follows: There are in operation four steam cylinders, with a total capacity of 14 tons in twenty-four hours. These cylinders are made of heavy castings, the upper and lower portions being separated by a perforated partition upon which the crude sulphur is placed. The upper portion has a capacity of about 2 tons admitted through a trap in the top, which is afterwards closed and made steam tight. Steam at a pressure varying from 60 to 70 pounds is admitted; the sulphur is melted in two or three hours and separated from impurities by flowing into the lower portion. This process is in general similar to that used at the Rabbit-Hole mines, having, however, in addition certain improvements patented by Mr. Dickert. The melted sulphur is drawn off into conical molds, after which it is ground to flour and packed in

sacks for shipment. Thus obtained it is said to be 99.80 fine; it is used for "sheep dip," a purpose said to consume annually many tons west of the Mississippi river. The immediate erection of chambers for the manufacture of "flowers of sulphur" is contemplated. These works are situated 23 miles east of Black Rock station on the Utah Central railroad. To this point the product is hauled in wagons. Thus far the output has been 53 car loads or 715 short tons.

The following information in regard to the geological features of the Cove Creek deposits has been obtained from a paper by Prof. G. vom Rath, from the *Neues Jahrbuch fur Mineralogie, etc.*, Band I., 1884, p. 259. "In the claim known as the 'Mammoth' a cut revealed limestone alternating with slaty clay. Limestone and slate are so impregnated with sulphur that pieces a foot in thickness consist almost entirely of sulphur in which only fragments of the neighboring rocks are contained, thus forming a conglomerate in which the largely predominating cement, sulphur, binds together small angular fragments of limestone and slate. In this claim, as also in others to be mentioned, gypsum, as a transformation product of limestone, appears in abundance. In all clefts and cavities the sulphur forms small octohedral crystals. Frequently the sulphur has a granular structure, the granules, 1 to 3 millimeters in size, consisting either entirely of sulphur or inclosing a very small fragment of rock. At the 'Sulphur King' claim the disintegrated rock was also observed to be impregnated with sulphur and in places essentially changed into sulphur. The surrounding rock is different from that of the Mammoth, consisting of a decomposed andesite of a friable character and filled with particles of sulphur. The four claims, Clear Creek, Cleveland, Cove Creek, and Washington, are included in an almost circular valley. Here, for a depth of about 28 feet, and covering the entire area of the circular plain, sulphur occurs either pure or richly impregnating disintegrated andesite. A number of excavations about 12 feet deep reveal the fact that the formation of sulphur is still taking place. In several excavations an elevated temperature, also water vapor and hydrogen sulphide, were noticed, and in clefts the most delicate crystals of sulphur, evidently newly formed. Gypsum is of very frequent occurrence in this valley; anhydrite also occurs, according to Mr. C. A. Semler. The surrounding region, as well as that more remote, abounds in warm springs and sulphur springs. The mass of sulphur in these four claims, according to the most moderate calculations (area 300,000 square meters, thickness 3 meters, mean percentage of sulphur 75), is calculated to be 1,350,000 tons.

"Among the almost numberless discoveries of volcanic origin there appears to be none which, in massiveness, can even approximately compare with the Cove Creek deposits, which are, futhermore, remarkable for high percentage of sulphur, averaging at least 75 per cent. and frequently exceeding 90 per cent."

One of the great obstacles encountered both in Sicily and in the western part of this country, where the processes of extracting and refining sulphur have been carried on, is scarcity of fuel. This difficulty is not found at Cove Creek, cedar wood being abundant and cheap; the price paid is $1.50 per cord, delivered on the premises. Water is piped a distance of 9,100 feet from the range, and has a head of 800 feet. Wages for men and teams are reasonable. It is claimed that the chief difficulty opposed to successful competition with Sicilian sulphur lies in the fact that practically refined sulphur is admitted as crude, thereby escaping the duty of $10 per ton imposed upon the refined article. The tariff limit for "crude" is 95 per cent.

The operations at Rabbit-hole springs, Humboldt county, Nevada, which, according to the last report, were declining, have since ceased altogether, owing to heavy running expenses incident to the barrenness of the country, and high transportation charges. It does not seem probable that the Humboldt company will resume operations very soon, owing to the great disadvantages with which it has to contend.

The consumption of sulphur on the Pacific coast is estimated at 3,500 tons per annum; nearly all of this is imported. Three thousand tons are used in the manufacture of sulphuric acid, the remainder supplying various demands, such as those of sheep herders, vine growers, etc. The price in San Francisco is at present $35 per ton.

The Louisiana sulphur beds, near Lake Charles, Calcasieu parish, on the line of the New Orleans and Texas railway, already mentioned and described in the last report, are now in the hands of a company of which Hon. Duncan F. Kenner is president. Nothing has as yet been accomplished toward extracting the sulphur, although there are indications that operations may be commenced in the near future. The difficulties to be encountered in extracting the sulphur from these deposits, according to Mr. D. M. Jewett, C. E., are not serious, and are mainly incident to the necessity of penetrating a stratum of quicksand 60 feet thick. Fuel and labor are cheap in this locality, and as the railway nearly touches the property containing these beds the transportation facilities are excellent. It is believed that sulphur from these beds could be delivered at the seaboard in New Orleans or Galveston at $20 per ton at a large profit.

*New discoveries.*—In regard to the sulphur referred to in the last report as occurring in Tom Green county, Texas, Mr. Jewett states that it is of excellent quality as revealed by specimens submitted to him, the impurity consisting of only 10 per cent. of gypsum. Beyond this little is known in regard to it.

Mr. Jewett further reports sulphur deposits north of Lone mountain or Red peak, 5 miles distant from the town of White Oaks, New Mexico. In these deposits the percentage of sulphur is about 50; gypsum occurs with it. The extent of these deposits is unknown.

A deposit of sulphur is also reported by Mr. C. G. Yale as having been discovered in Kern county, California, during the last year. It

is said to furnish quite pure sulphur, though nothing is yet known of its extent.

No attempt was made during 1885 to develop the known sulphur beds in Wyoming and other Rocky Mountain Territories, but the beds have been made the subject of careful study and investigation, and it seems likely that during 1886 an attempt will be made to produce sulphur for the market, either from the beds near Evanston, Wyoming, or else from those on the Utah Central railway in Utah.

*Imports.*—The amounts of crude and refined sulphur imported during 1885 show only slight changes over the two previous years. The following table shows the importations to 1885, inclusive:

*Sulphur imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Crude. | | Flowers of sulphur. | | Refined. | | Ore.(a) | Total value. |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Value. | |
| | *Long tons.* | | *Long tons.* | | *Long tons.* | | | |
| 1867 | 24,544.10 | $620,373 | 110.05 | $5,509 | 250.55 | $10,915 | ..... | $636,797 |
| 1868 | 18,150.55 | 446,547 | 16.48 | 948 | 64.75 | 2,721 | ..... | 450,216 |
| 1869 | 23,589.69 | 678,642 | 96.59 | 4,576 | 645.04 | 27,149 | ..... | 710,367 |
| 1870 | 27,379.60 | 819,408 | 76.34 | 3,927 | 157.24 | 6,528 | $1,269 | 831,132 |
| 1871 | 36,131.46 | 1,212,448 | 65.54 | 3,514 | 92.26 | 4,328 | 754 | 1,221,044 |
| 1872 | 25,379.55 | 764,798 | 35.97 | 1,822 | 56.94 | 2,492 | ..... | 769,112 |
| 1873 | 45,533.27 | 1,301,000 | 55.29 | 2,924 | 35.97 | 1,497 | ..... | 1,305,421 |
| 1874 | 40,989.55 | 1,260,491 | 51.08 | 2,694 | 56.68 | 2,403 | ..... | 1,265,588 |
| 1875 | 39,683.10 | 1,259,472 | 17.83 | 891 | ..... | ..... | ..... | 1,260,363 |
| 1876 | 46,434.72 | 1,475,250 | 41.07 | 2,114 | 43.87 | 1,927 | ..... | 1,479,291 |
| 1877 | 42,962.69 | 1,242,888 | 116.34 | 5,873 | 1,170.80 | 26,962 | ..... | 1,285,723 |
| 1878 | 48,102.46 | 1,179,769 | 158.71 | 7,628 | 149.51 | 5,935 | ..... | 1,193,332 |
| 1879 | 70,370.28 | 1,575,533 | 137.60 | 6,509 | 68.94 | 2,392 | ..... | 1,584,434 |
| 1880 | 87,837.25 | 2,024,121 | 123.70 | 5,516 | 153.36 | 5,262 | ..... | 2,034,899 |
| 1881 | 105,096.54 | 2,713,485 | 97.66 | 4,226 | 70.96 | 2,555 | ..... | 2,720,266 |
| 1882 | 97,504.15 | 2,627,402 | 158.91 | 6,926 | 58.58 | 2,196 | ..... | 2,636,524 |
| 1883 | 94,539.75 | 2,288,946 | 79.13 | 3,262 | 115.33 | 4,487 | ..... | 2,296,695 |
| 1884 | 105,113.19 | 2,242,697 | 178.00 | 7,869 | 126.00 | 4,765 | ..... | 2,255,331 |
| 1885 | 96,839.44 | 1,941,943 | 120.56 | 5,351 | 114.08 | 4,060 | ..... | 1,951,354 |

*a* Latterly classed under head of pyrites.

Importation from Japan is increasing, and would be more regular but for the necessity of buying the article several months before it can reach New York; meanwhile the price may change.

*Statement by countries and by customs districts, showing the imports into the*

[Quantities expressed in long cwts.]

| Countries whence exported and customs districts through which imported. | 1876. | | 1877. | | 1878. | | 1879. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| COUNTRIES. | | | | | | | | |
| Austria | | | 3,320 | $7,098 | | | | |
| Belgium | | | | | 2,590 | $5,242 | | |
| Brazil | | | 246 | 833 | | | | |
| England | 371 | $914 | 298 | 806 | 168 | 469 | 352 | $693 |
| Scotland | 338 | 683 | 214 | 427 | | | | |
| France | 1,666 | 4,071 | 4,577 | 10,780 | 3,850 | 9,174 | 4,774 | 10,270 |
| Germany | | | | | | | | |
| Italy | | | 16,800 | 22,720 | 20 | 39 | | |
| Japan | | | 3,584 | 6,204 | | | | |
| Total | 2,375 | 5,668 | 29,039 | 48,868 | 6,628 | 14,924 | 5,126 | 10,963 |
| DISTRICTS. | | | | | | | | |
| Boston & Charlestown, Massachusetts | | | | | | | | |
| New York, New York | 338 | 683 | 21,170 | 32,348 | 76 | 166 | 915 | 1,534 |
| Philadelphia, Pennsylvania | | | | | 2,590 | 5,240 | | |
| San Francisco, California | 2,037 | 4,985 | 7,869 | 16,520 | 3,962 | 9,518 | 4,211 | 9,429 |
| Total | 2,375 | 5,668 | 29,039 | 48,868 | 6,628 | 14,924 | 5,126 | 10,964 |

*a* The total imports entered for consumption in the United States in the fiscal year 1885 were 2,411 "refined sulphur," valued at $4,060.

*Statement by countries and by customs districts, showing the imports into the United*

[Quantities expressed in long tons.]

| Countries whence exported and customs districts through which imported. | 1876. | | 1877. | | 1878. | | 1879. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| COUNTRIES. | | | | | | | | |
| Austria | | | | | | | | |
| Dutch West Indies and Dutch Guiana | 1,515 | $15,427 | | | | | | |
| England | 30 | 1,211 | 425 | $14,631 | (1) | $16 | 2 | $335 |
| Scotland | 24 | 910 | 472 | 13,231 | 160 | 3,961 | 866 | 19,287 |
| Gibraltar | | | 290 | 7,789 | | | | |
| Quebec, Ontario, Manitoba, and the Northwest Territory | | | | | 12 | 264 | | |
| France | | | | | | | | |
| French West Indies | | | | | | | | |
| Greece | | | | | | | | |
| Italy | 46,941 | 1,439,839 | 41,819 | 1,194,000 | 47,494 | 1,161,367 | 64,420 | 1,453,138 |
| Japan | 456 | 16,291 | 437 | 13,137 | 256 | 7,548 | 224 | 4,528 |
| Portugal | | | | | | | 467 | 10,410 |
| San Domingo | | | | | | | | |
| Spain | | | | | | | | |
| Spanish Possessions in Africa and adjacent islands | | | | | | | | |
| Total | 48,966 | 1,473,678 | 43,443 | 1,242,788 | 47,922 | 1,173,156 | 65,919 | 1,487,698 |
| DISTRICTS. | | | | | | | | |
| Baltimore, Maryland | 5,157 | 157,828 | 3,882 | 105,175 | 5,455 | 138,202 | 6,969 | 157,243 |
| Barnstable, Massachusetts | | | | | | | 600 | 13,780 |
| Beaufort, South Carolina | | | | | | | | |
| Boston & Charlestown, Massachusetts | 5,031 | 154,883 | 3,931 | 101,215 | 5,795 | 131,945 | 7,841 | 173,506 |
| Charleston, South Carolina | | | | | 526 | 12,267 | 605 | 13,812 |
| Delaware, Delaware | 450 | 13,500 | | | | | 890 | 21,907 |
| Huron, Michigan | | | | | 12 | 264 | | |
| Middletown, Connecticut | | | | | | | | |
| Newark, New Jersey | | | 1,071 | 31,802 | 462 | 13,240 | 443 | 10,175 |
| New Orleans, Louisiana | 172 | 5,705 | 150 | 4,750 | | | 100 | 2,087 |
| New York, New York | 24,524 | 721,092 | 21,867 | 654,997 | 28,240 | 690,989 | 36,543 | 827,193 |
| Philadelphia, Pennsylvania | 12,549 | 385,071 | 9,216 | 256,224 | 6,657 | 167,222 | 11,704 | 263,467 |
| Providence, Rhode Island | 600 | 18,232 | 1,739 | 45,487 | 519 | 11,479 | | |
| Richmond, Virginia | | | | | | | | |
| San Francisco, California | 483 | 17,367 | 862 | 27,768 | 256 | 7,548 | 224 | 4,528 |
| Savannah, Georgia | | | 725 | 15,370 | | | | |
| Total | 48,966 | 1,473,678 | 43,443 | 1,242,788 | 47,922 | 1,173,156 | 65,919 | 1,487,698 |

*United States of refined sulphur each fiscal year, from* 1875 *to* 1885 *inclusive.*

[Quantities expressed in long cwts.]

| 1880. | | 1881. | | 1882. | | 1883. | | 1884. | | 1885(a). | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | 201 | $389 | ..... | ..... | 212 | $473 | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 624 | $1,169 | 397 | 763 | 388 | $862 | 495 | 1,089 | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 2,556 | 4,361 | 2,354 | 4,728 | 5,901 | 11,333 | 1,708 | 3,357 | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | 106 | 254 | 97 | 231 | ..... | ..... | ..... | ..... |
| ..... | ..... | 120 | 241 | 1,496 | 3,202 | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3,180 | 5,530 | 3,072 | 6,121 | 7,891 | 15,651 | 2,512 | 5,150 | 6,080 | 12,634 | ..... | ..... |
| 440 | 671 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 10 | 30 | 322 | 635 | 16 | 122 | 5 | 16 | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 2,730 | 4,829 | 2,750 | 5,486 | 7,875 | 15,529 | 2,507 | 5,134 | ..... | ..... | ..... | ..... |
| 3,180 | 5,530 | 3,072 | 6,121 | 7,891 | 15,651 | 2,512 | 5,150 | 6,080 | $12,634 | 4,693 | $9,431 |

long hundredweights of "flowers of sulphur," valued at $5,351; and 2,282 long hundredweights of

*States of crude sulphur or brimstone each fiscal year, from* 1875 *to* 1885 *inclusive.*

[Quantities expressed in long tons.]

| 1880. | | 1881. | | 1882. | | 1883. | | 1884(a). | | 1885(a). | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 1 | $22 | ..... | ..... | ..... | ..... | 13 | $379 | ..... | ..... | ..... | ..... |
| 1,664 | 36,444 | 1,668 | $43,311 | 755 | $20,294 | 3 | 88 | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 988 | 23,580 | ..... | ..... | 526 | 13,770 | 34 | 858 | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | 2 | 8 | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | 500 | 13,927 | ..... | ..... | ..... | ..... | ..... | ..... |
| 80,301 | 1,862,712 | 102,771 | 2,645,293 | 92,944 | 2,504,862 | 92,861 | 2,248,870 | ..... | ..... | ..... | ..... |
| 282 | 4,744 | 691 | 16,253 | 2,980 | 66,356 | 1,038 | 23,714 | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | 240 | 7,875 | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | 308 | 8,637 | ..... | ..... | 500 | 12,856 | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | 9 | 310 | 87 | 2,030 | ..... | ..... | ..... | ..... |
| 83,236 | 1,927,502 | 105,438 | 2,713,494 | 97,956 | 2,627,402 | 94,536 | 2,288,795 | 105,143 | $2,242,678 | 96,839.44 | $1,941,943 |
| 13,827 | 313,342 | 16,477 | 430,917 | 13,781 | 364,384 | 11,977 | 286,438 | 15,037 | 303,226 | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 650 | 16,163 | ..... | ..... |
| ..... | ..... | ..... | ..... | 540 | 13,889 | ..... | ..... | 600 | 13,259 | ..... | ..... |
| 8,207 | 183,486 | 8,860 | 226,801 | 7,467 | 194,317 | 7,756 | 173,569 | 5,294 | 112,152 | ..... | ..... |
| 1,061 | 25,398 | 3,065 | 78,741 | 6,025 | 161,281 | 4,051 | 106,235 | 6,125 | 132,570 | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | 9 | 310 | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 280 | 7,121 | 100 | 2,646 | 220 | 6,516 | 428 | 10,378 | ..... | ..... | ..... | ..... |
| 46,657 | 1,083,784 | 57,608 | 1,463,082 | 46,531 | 1,260,222 | 45,385 | 1,110,313 | 52,478 | 1,135,725 | ..... | ..... |
| 10,679 | 254,892 | 17,987 | 477,547 | 14,839 | 408,611 | 22,772 | 549,095 | 18,786 | 401,468 | ..... | ..... |
| 1,255 | 31,155 | 650 | 17,507 | 1,244 | 33,036 | 535 | 13,830 | 651 | 15,517 | ..... | ..... |
| ..... | ..... | ..... | ..... | 660 | 17,760 | ..... | ..... | ..... | ..... | ..... | ..... |
| 1,270 | 28,324 | 691 | 16,253 | 6,054 | 151,234 | 1,072 | 24,572 | 5,522 | 112,598 | ..... | ..... |
| ..... | ..... | ..... | ..... | 586 | 15,842 | 560 | 14,365 | ..... | ..... | ..... | ..... |
| 83,236 | 1,927,502 | 105,438 | 2,713,494 | 97,956 | 2,627,402 | 94,536 | 2,288,795 | 105,143 | 2,242,678 | 96,839.44 | 1,941,943 |

a Sources not reported.

In addition to the above amounts some lac sulphur has been imported as follows:

*Lac sulphur imported and entered for consumption in the United States, 1879 to 1885, inclusive.*

| Fiscal years ending June 30— | Quantity. | Value. |
|---|---|---|
| | *Pounds.* | |
| 1879 | 10,012 | $880 |
| 1880 | 13,903 | 1,238 |
| 1881 | ..... | 775 |
| 1882 | 28,217 | 2,137 |
| 1883 | 30,197 | 2,072 |
| 1884 | 36,083 | 2,954 |
| 1885 | (a) | (a) |

a Not specified.

*Prices.*—The price of refined sulphur has not changed markedly; it averaged $40 per ton during 1885. Crude sulphur advanced slightly early in the year, but at the close had reached $22.75 per long ton. The average price was $22.40.

*Utilization.*—In addition to the more common and well-known purposes for which sulphur is used and which were discussed in the last report, its use as a "sheep dip," for the prevention of certain skin diseases in these animals, is one which is creating a large and increasing demand for the article. As already stated, large amounts are now used for this purpose west of the Mississippi river.

The crude sulphur imported from Sicily is largely used for the manfacture of sulphuric acid; of this substance it is estimated that 290,000 short tons were made from sulphur, and 153,000 tons from pyrites during the year 1885.

The total production and foreign shipments of Italian sulphur have been furnished through the courtesy of the Italian secretary of legation, Mr. A. de Forestà, as follows:

*Production and foreign exports of sulphur in Sicily, 1882 to 1885, inclusive.*

| Years. | Production. | Exports. |
|---|---|---|
| | *Metric tons.* | *Metric tons.* |
| 1882 | 394,093 | 265,557 |
| 1883 | 391,689 | 281,746 |
| 1884 | 367,712 | 270,704 |
| 1885 | 371,745 | 279,206 |

*Total production for the Kingdom of Italy, 1882 to 1885, inclusive.*

| Years. | Production. | Exports. |
|---|---|---|
| | *Metric tons.* | *Metric tons.* |
| 1882 | 445,918 | 273,347 |
| 1883 | 446,508 | 288,381 |
| 1884 | 410,987 | 277,210 |
| 1885 | 419,538 | 289,257 |

# PYRITES.

By Herbert J. Davis.

## OCCURRENCE IN THE UNITED STATES.

*New Hampshire.*—Since the report for 1884, considerable and radical changes have been made in handling the output of the Milan mine, at Milan, Coos county. Increasing quantities of copper and silver, and, in some parts of the mine, gold, have caused the managers to pay more attention to smelting the ores, and to this end extensive works have been erected at Portland to handle the entire output. The ore is now sorted into two grades:

*Analyses of Milan pyrites.*

| | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Sulphur | 46.00 | 35.00 |
| Copper | 3.75 | 5.00 |
| Iron | 40.00 | 30.50 |
| Silica, etc | 6.25 | 21.50 |
| Zinc | 4.00 | 8.00 |
| Totals | 100.00 | 100.00 |

Both No. 1 and No. 2 ores find a ready market among the acid manufacturers. The cinder is returned to Portland and is smelted with raw "fines" and raw siliceous ores from the mine, containing from 3 to 4 per cent. of copper. The smelting is done in Bartlett water-jacket furnaces at small expense. A large proportion of the zinc is saved as oxide by a special process. The concentration of the gold and silver in the mattes is quite remarkable; the silver contents latterly amounting to nearly the same value as the copper, while the slags are so free from silver that fire assays usually give blank results. One notable feature, which may be mentioned in connection with this mine, is the fact that the ore is so well liked among the acid men that no trouble is experienced in getting ores burned when running as low as 33 per cent. in sulphur contents, while the demand for the No. 1 ore is at all times far ahead of the capacity of the mine. Contrary to the published opinion of experts, no difficulty is found in burning low-grade ores; no particular excess of air is required over that actually needed to oxidize the sulphur, since the density of the gas is kept up by using an increased

thickness of ore on the grate bars of the burners, as much as 3 feet 6 inches thickness having in many cases proved not excessive, nor has clinkering been great enough to cause any trouble. Grates burning 700 to 800 pounds of rich ore will burn 1,100 to 1,200 pounds of this low-grade ore, consequently the labor bills are considerably larger than in the case of high-grade ore.

No excessive faulting nor diminution in the ore bodies has yet been encountered in working the Milan mine, and it is reasonable to suppose that the deposit will last an indefinite time. The output of the mine at the present time is 2,600 tons per month, divided as follows:

*Monthly output of the Milan mine.*

| | Tons. |
|---|---|
| No. 1 ore | 1,000 |
| No. 2 ore | 800 |
| Fines and copper ore | 800 |
| Total | 2,600 |

*Vermont.*—The pyrites deposits of Vermont are probably greater in extent than any others in the United States. Unfortunately, little, if any, of this large quantity is of any value for making sulphuric acid, as it is mostly pyrrhotite. The Elizabeth mine, at South Strafford, has perhaps the largest deposit of pyrites. It is considered to be a contact vein, and is very wide, being in some places upwards of 40 feet. This mine is not at present in operation, the low price of copper making it impossible to work it profitably. The ore was dressed to 6.5 per cent. copper.

*Analysis of pyrites from the Elizabeth mine.*

| | Per cent. |
|---|---|
| Sulphur | 33.00 |
| Iron | 50.00 |
| Copper | 3 50 |
| Silica and insoluble matter | 13.50 |
| Total | 100.00 |

The Ely mines at West Fairlee have also a large deposit of pyrrhotite and have been very extensively worked for copper. At present the mines are idle, only sufficient work being done to keep them free from water. A considerable quantity of the ore raised has been mundic, nearly barren of copper, and its sulphur contents are of no value for making acid.

At Walcotville there is a large deposit of pyrrhotite on which but little work has been done. There are one or two other points where pyrrhotite exists in quite large quantities, but no work has been done

on them for several years, the copper contents being too low, and the sulphur valueless. The analysis of the Walcot ore is:

*Analysis of pyrites from Walcotville, Vermont.*

| | Per cent. |
|---|---|
| Sulphur | 34.40 |
| Iron | 32 70 |
| Copper | 3.27 |
| Silica and insoluble matter | 29.50 |
| Total | 99.87 |

*Massachusetts.*—The Davis mines, situated in the southeastern part of Rowe, Franklin county, are the only producers of pyrites in this State. These mines were opened in June, 1882, on the top of an immense outcrop of almost pure iron pyrites. The main shaft is now more than 400 feet in depth, following the dip (21°) of the deposit. There are five levels and the same number of stopes opened in both directions along the strike of the ore body. The vein or ore body maintains its size, and in several places is more than double the surface width. The policy of the company has been to drive the development work at least one year ahead of its requirements, and by this means there are always tens of thousands of tons of ore that can be extracted at any moment quickly and cheaply. The quantity mined during 1885 was upwards of 30,000 tons, nearly all of which was sold for consumption. The company keeps an ore reserve at the mines and railway of about 10,000 tons. This is in the form of lump, broken, and "smalls" ore, separated and prepared for immediate shipment. This quantity is in excess of the regular shipments.

*Proportion of monthly shipments of lump, broken, and "smalls" ores.*

| Sizes. | Tons. |
|---|---|
| Lump ore, 8 inches in diameter and over | 800 |
| Broken ore, less than 3 inches in diameter and over three-fourths inch in diameter | 1,900 |
| "Smalls" ore, nothing larger than one-fourth inch in diameter | 900 |
| Total | 3,600 |

But one grade of ore is produced, the lowest workings yielding identically the same grade of ore as the first openings of the mine. The width and continuity of the ore body, as well as its great length, depth, and purity make it one of the most remarkable pyrites deposits known. The following analysis is the mean of over one hundred separate tests:

*Analysis of pyrites from Rowe, Massachusetts.*

| | Per cent. |
|---|---|
| Sulphur | 49.27 |
| Iron | 45.30 |
| Copper | 1.47 |
| Silica and insoluble matter | 3.83 |
| Total | 99.87 |

The company has recently secured the property north of the present mines, which is known to carry the vein. Surveys are being made at the present time for a standard gauge railroad to run from the mines, connecting with the State railroad at a point about half a mile below the Charlemont station.

*New York.*—Saint Lawrence is the only county at present producing pyrites on a commercial scale in this State. The mines are at Hermon, about six miles from the railway at De Kalb Junction on the Rome, Watertown and Ogdensburg railroad. The pyrites from these mines is a bisulphide and burns freely, parting with its sulphur readily, the siliceous character of the ore permitting larger quantities than usual to be burned in a kiln. These ores are very hard and make few smalls. Most of the product for 1885 was shipped to acid works in the West; it amounted to about 2,000 tons. The following is the analysis:

*Analysis of pyrites from Saint Lawrence county, New York.*

| | Per cent. |
|---|---|
| Sulphur | 38.00 |
| Iron | 34.00 |
| Copper | 3.00 |
| Silica and insoluble matter | 25.00 |
| Total | 100.00 |

Near Ellenville, Ulster county, is a deposit of pyrites which has been worked more or less during the past year. The vein matter is about 6 feet wide, and the ore between 2 and 3 feet. The main shaft is about 40 feet deep, with the vein widening as it descends. The water came in so freely that the work was stopped until pumping facilities could be provided. The following is the mean of two analyses:

*Analysis of pyrites from Ulster county, New York.*

| | Per cent. |
|---|---|
| Sulphur | 39.12 |
| Iron | 34.16 |
| Silica | 26.69 |
| Copper | Trace. |
| Total | 99.97 |

*Virginia.*—The mines at Tolersville, Louisa county, on the Chesapeake and Ohio railroad, are the only pyrites mines at present operated in this State.

The mines of the Arminius Copper Mines Company are situated about 1½ miles from Tolersville, and have a tramway and railway from the mines to the main line of the Chesapeake and Ohio railroad. This company has four shafts sunk to various depths through the "iron hat," in the pyrites deposit. The main shaft has been sunk to a depth of

375 feet on the dip of the deposit (63°), all in ore. The ore in sight amounts to many thousand tons. During 1885 the company mined about 9,000 tons. New crushing and concentrating machinery for working the ores on a large scale for copper, together with an air compressor for running power drills and underground pumping machinery, have been added in the past year. The following is the analysis:

*Analysis of pyrites from the Arminius mines, Virginia.*

| | Per cent. |
|---|---|
| Sulphur | 49.50 |
| Iron | 43.55 |
| Copper | .48 |
| Silica and insoluble matter | 6.43 |
| Total | 99.96 |

The Sulphur Mines Company, of Virginia, has a large body of pyrites situated about 1 mile northeast of the Arminius mines, on the same deposit. There is a branch railway from Tolersville to the mines. The workings are quite extensive, and several shafts have been sunk upon the vein and through the gossan to the pyrites. The analysis of the ore is practically the same as that of the Arminius. The output from these mines in 1885 was about 4,000 tons.

The property owned by Mr. Charles Lennig has not been worked since the last report.

*North Carolina.*—There is a deposit of pyrites near Gastonia, in Gaston county. This deposit is small on the surface, being about 2 feet in width, and can be traced for half a mile or more. A shaft was sunk on the vein to a depth of about 45 feet, when the ore gave out. The analysis gave the following results:

*Analysis of pyrites from Gaston county, North Carolina.*

| | Per cent. |
|---|---|
| Sulphur | 44.00 |
| Iron | 36.00 |
| Copper | Trace. |
| Silica and insoluble matter | 20.00 |
| Total | 100.00 |

This ore was supposed to carry from $6 to $10 per ton in gold, which proved not to be the case.

Near Charlotte, Mecklenburgh county, is a pyrites mine, which is being worked for gold and apparently, with success. The average is nearly $7 per ton in gold. The sulphur is not utilized, as it is too much mixed with rock. The vein varies from 1 to 7 feet in width, the deepest workings being over 300 feet. The ore is crushed and pulverized, and the gold is saved on Rittinger tables.

There are many places where the promise of pyrites is good, but on investigation the deposits are usually found to be narrow and of no value unless they contain gold in workable quantity.

*Georgia.*—Some 4 miles south of Dallas, in Paulding county, on the East Tennessee, Virginia and Georgia railway, is a pyrites mine which has produced considerable ore, supplying the acid works at Atlanta, Georgia, and later those at Nashville, Tennessee. The ore channel is about 7 feet wide and dips about 40°. The shaft is a little more than 200 feet deep. There has been some faulting of the ore body, but there is little doubt that it will easily be found, and be as productive as ever. This mine is quite similar to the one in Haralson county, described in the last report. The analysis of the Paulding county ore is:

*Analysis of pyrites from Paulding county, Georgia.*

| | Per cent. |
|---|---|
| Sulphur | 41.00 |
| Iron | 37.00 |
| Copper | 4.00 |
| Silica and insoluble matter | 18.00 |
| Total | 100.00 |

*Tennessee.*—Ducktown, in the extreme southeasterly part of the State, contains the largest known deposit of pyrites south of Virginia. The immense body of pyrites here is like the deposits of Vermont—mainly a pyrrhotite, and of little value as an acid producer. These mines have been worked extensively for copper since 1852. The composition of the ore is:

*Analysis of pyrites from Ducktown, Tennessee.*

| | Per cent. |
|---|---|
| Sulphur | 35.00 |
| Iron | 40.00 |
| Silica | 12.00 |
| Copper | 5.00 |
| Lime | 6.00 |
| Alumina, etc | 2.00 |
| Total | 100.00 |

*Alabama.*—The pyrites deposits of Alabama are at present too far from means of transportation to be of value. As railroads are run nearer to the bodies of pyrites known to exist in this section, no doubt they will become of importance for making acid for treating the phosphates required in Alabama and contiguous States.

### FOREIGN DEPOSITS.

*Canada.*—The mines at Capelton produced less pyrites in 1885 than in the year previous. The mines of the Canadian Copper and Sulphur Company have been idle the entire year. The Albert mine has slightly

increased its output, and the Orford Copper and Sulphur Company's mine has yielded about its usual yearly quantity. The output of these two mines in 1885 was about 35,000 tons. This ore was first burned for making sulphuric acid, and the cinder smelted into copper matte, the greater part of which was shipped to England for refining. These ores carry about an ounce of silver for each per cent. of copper which is extracted from the matte. Both of these mines are in a flourishing condition and are in the midst of large ore bodies. Their capacity to produce merchantable ore is only limited by the number of men they employ. Messrs. G. H. Nichols & Co. have built an elevated tramway from their mine to the station at Capelton. This will give them a carrying capacity of nearly 400 tons daily, at a minimum cost. The Orford company runs its ore in the same cars in which it is raised from the mine, through an adit of about 1,000 feet in length, thence to the cobbing shed and Passumpsic River railway at Eustis, half a mile below Capelton. These ores, while carrying workable quantities of copper, burn with great freedom. The Albert and Orford mines are on the same deposit, and adjoining, and while the ore differs slightly in some respects, the main part of the ore mined is practically the same in both mines. The analysis, taken from an average of several, is as follows:

*Analysis of pyrites from Capelton, Canada.*

| | Per cent. |
|---|---|
| Sulphur | 40.21 |
| Iron | 35.20 |
| Silica | 19.43 |
| Copper (wet assay) | 5.10 |
| Total | 99.94 |
| Copper (dry assay) | 3.80 |

*Newfoundland.*—There have been several offers of pyrites from Newfoundland mines during the past season. About 2,500 tons were received, but did not give satisfaction, the user returning to his former source of supply. There are unquestionably some good deposits of iron pyrites in Newfoundland, but they are all on the northeastern coast, nearly 400 miles from Saint John, and inaccessible for the greater part of the year.

*Spain and Portugal.*—The enormous deposits of pyrites of Spain and Portugal have been the subject of several exhaustive and able articles, which have been published from time to time during the past two or three years, in nearly all the scientific and technical journals of Europe and America. It will only be necessary to repeat their general bearing upon this country.

The quantities of pyrites extracted from the Rio Tinto mine during the last four years have been as follows:

*Pyrites production of the Rio Tinto mine.*

| Years. | Exported for making acid. | For treatment at the mines. | Total. | Average copper contents. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Per cent.* |
| 1882 | 259,924 | 688,307 | 948,231 | 2.805 |
| 1883 | 313,291 | 786,682 | 1,099,973 | 2.956 |
| 1884 | 312,028 | 1,057,890 | 1,369,918 | 3.234 |
| 1885 | | | | |

There is about 1 ounce of silver per ton in the Spanish ores, and about 9 grains of gold. The silver is saved at small expense, but the gold, it is believed, has not been extracted at a profit. The analyses of the Spanish and Portugese pyrites are practically the same. The Rio Tinto and Tharsis mines are in Spain, and the San Domingo or Mason & Barry Company's mine in Portugal. Huelva is the shipping port in Spain, and Pomaron in Portugal. Most of the pyrites coming to this country is shipped as ballast in vessels carrying fruit or other cargoes that require a certain quantity of some very heavy compact material. The rate of freight is from $2 to $3 per ton to United States ports.

The following analyses are the mean of several and give the character of the pyrites for shipment:

*Analyses of Spanish and Portuguese pyrites.*

| | Rio Tinto. | | Tharsis. | | San Domingo. | |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Sulphur | 47.76 | 48.98 | 47.21 | 48.11 | 49.00 | 48.60 |
| Iron | 43.99 | 43.00 | 43.50 | 41.20 | 43.50 | 43.70 |
| Copper | 3.69 | 3.29 | 3.21 | 3.11 | 2.76 | 2.90 |
| Lead | .10 | 1.47 | 1.22 | 2.20 | .02 | .11 |
| Zinc | .24 | .62 | .27 | .81 | .10 | .17 |
| Arsenic | .83 | .90 | .83 | 1.21 | .68 | .47 |
| Silica and insoluble matter | 2.99 | 1.74 | 3.71 | 3.26 | 3.89 | 4.05 |
| Totals | 99.60 | 100.00 | 99.95 | 99.90 | 99.95 | 100.00 |

In order to evade paying duty on the copper contents of pyrites, the shippers have recently sent pyrites to the United States graded below the tariff copper limit (3½ per cent.) and paying duty only as pyrites ore. The cinder, of course, has no value, and is not returned, the buyers agreeing not to use or allow others to make commercial use of it.

## DOMESTIC PRODUCTION.

*Quantity and spot value of pyrites mined in the United States (in part estimated).*

| Years. | Quantity. | Average value per ton. | Total value. |
|---|---|---|---|
| | *Long tons.* | | |
| 1882 | 12,000 | $6.00 | $72,000 |
| 1883 | 25,000 | 5.50 | 137,500 |
| 1884 | 35,000 | 5.00 | 175,000 |
| 1885 | 49,000 | 4.50 | 220,500 |

## MANUFACTURING.

*Works burning pyrites and quantity burned annually in the United States.*

| Districts. | Number of works in 1885. | Consumption (long tons). | | | | |
|---|---|---|---|---|---|---|
| | | 1881. | 1882. | 1883. | 1884. | 1885. |
| Boston and eastern district | 6 | ..... | 2,500 | 7,500 | 14,500 | 25,800 |
| New York district | 7 | 7,000 | 23,900 | 29,500 | 39,000 | 44,600 |
| Philadelphia district | 2 | ..... | 2,500 | 5,000 | 5,500 | 11,500 |
| Baltimore and southern States | 3 | ..... | ..... | 2,000 | 4,000 | 7,500 |
| Western district | 1 | ..... | ..... | 1,000 | 2,000 | 2,000 |
| Total | 19 | 7,000 | 28,900 | 45,000 | 65,000 | 91,400 |

*Pyrites mined, imported, and consumed in the United States,* 1881 *to* 1885, *inclusive.*

| Years. | Mined. | Imported. | Total. | Consumed. | Stock on hand December 31. |
|---|---|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* | *Long tons.* |
| 1881 | ..... | 11,927 | 11,927 | 7,000 | 4,927 |
| 1882 | 12,000 | 29,818 | 41,818 | 28,900 | 17,845 |
| 1883 | 25,000 | 35,811 | 60,811 | 45,000 | 33,656 |
| 1884 | 35,000 | 44,250 | 79,250 | 68,500 | 44,406 |
| 1885 | 49,000 | 47,500 | 96,500 | 91,400 | 49,500 |

The stock on hand December 31, 1885, is distributed as follows:

| | Long tons. |
|---|---|
| At works | 28,500 |
| At mines | 21,000 |
| Total | 49,500 |

## IMPORTS.

*Imports of pyrites into the United States from* 1881 *to* 1885, *inclusive.*

| Fiscal year ending June 30— | Canadian. | | | | | Newfoundland. | Spanish and Portuguese | Total. |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Copper contents.(a) | | Value. | Duty. | | | |
| | *Tons.* | *Per cent.* | *Pounds.* | | | *Tons.* | *Tons.* | *Tons.* |
| 1881 | 10,812 | 4.0 | 982,899 | $102,543 | $29,786 | ..... | 1,115 | 11,927 |
| 1882 | 23,980 | 3.0 | 1,591,814 | 160,473 | 47,754 | ..... | 5,838 | 29,818 |
| 1883 | 25,211 | 2.5 | 1,403,900 | 134,400 | 39,879 | ..... | (b) 10,600 | 35,811 |
| 1884 (c) | 26,000 | 3.7 | 2,154,800 | ..... | ..... | 2,000 | 16,250 | 44,250 |
| 1885 (c) | 34,123 | 3.85 | 2,949,363 | 280,189 | 73,734 | 2,500 | 16,600 | 53,223 |

*a* Copper contents—these are "dry assays"—1.30 per cent. less than actual (wet) assays. The Spanish ore imported has contained an average of only 1.25 per cent. copper (wet assay). Newfoundland ore contained about 3 per cent. wet assay.

*b* "Spanish" pyrites includes 1,473 tons Portuguese (Mason & Barry) in 1883. The balance is almost all Rio Tinto ore.

*c* All the figures for 1884 and 1885 are estimated, as also is the quantity of Spanish ore for 1883. This has been rendered necessary by the practice of some of the custom-houses not keeping pyrites separate from iron ores.

*Quantity of imported pyrites containing not more than 3½ per cent. copper.*

| Years. | Tons. | Value. | Duty. |
|---|---|---|---|
| 1884 | 16,250 | $50,632 | $12,532 |
| 1885 | 6,078 | 18,577 | 4,559 |

Above quantities are included in table of imports.

It will be observed that the greater part of the imported pyrites contains over 3½ per cent. copper. From this it appears that it does not pay to import pyrites with copper contents too low to pay for its extraction.

*Approximate pyrites consumption of the world in* 1885.

| Countries. | Consumption. |
|---|---|
| | *Long tons.* |
| Great Britain | 620,000 |
| France | 200,000 |
| Germany | 150,000 |
| United States | 91,400 |
| Hungary | 60,000 |
| All other countries | 80,000 |
| Total | 1,201,400 |

It is possible that this estimate is not large enough by at least 200,000 tons, for many small works using pyrites or blendes mined in their neighborhood make no report.

*Annual export of crude brimstone from Sicily.*

| Years. | Total exports. | Imported into the United States. |
|---|---|---|
| | *Metric tons.* | *Long tons.* |
| 1865 | 138,232 | 24,544 |
| 1870 | 172,751 | 27,379 |
| 1875 | 217,926 | 39,683 |
| 1880 | 376,316 | 87,837 |
| 1885 | 289,257 | 96,839 |

This table shows at a glance the increased use of brimstone as well as pyrites since 1865. The quantity of sulphuric acid required throughout the world is increasing annually, and notwithstanding the success of the ammonia-soda process the quantity demanded is still very large even in England. So far as can be seen there is no prospect of the extinction of the Le Blanc process. Several of the large chemical companies in England have bought salt lands in South Durham, and will produce their own salt at a minimum cost.

The quantity of acid required to make high explosives is also very large, caused mainly by the increased use of power drills in most mines, railway tunnels, and quarries, and a consequent increased use of dynamite. Pyrites acid has been used for this purpose.

Artificial fertilizers are consuming about 45 per cent. of the sulphuric acid manufactured in the United States. That this quantity will be greatly exceeded very soon is unquestioned. The amount of artificial fertilizers sold in the United States is upwards of 1,000,000 tons annually, the greater part of which is prepared by the use of sulphuric acid. Well informed persons express themselves as confident that this quantity will be more than doubled within the next five years. The quantity of 50° acid required to acidulate one ton of Charleston rock is about 1,700 pounds.

The increased use of pyrites in the United States during the year 1885 has been very marked. The increase has been mostly through the addition of new furnaces by those who had previously adopted pyrites, a most positive proof of its success. These additional furnaces have been for the greater part smalls (or fines) furnaces, the lower prices of pyrites in this form being sufficient inducement for their erection. With one or two exceptions this increase has been north of Philadelphia, and confined to the vicinity of New York, and to New England. Several works in the West are now building pyrites furnaces, and will become consumers by midsummer of 1886. The apathy of manufacturers of sulphuric acid in the South toward pyrites as a raw material is inexplicable. One looks to the manufacturers of phosphates at the center of production as the natural users of a reagent which so materially reduces the cost of the merchantable article. That a very large saving is effected in the manufacture of artificial fertilizers by the use of pyrites acid is no longer questioned.

The indications for the year 1886 point to a further increase in the use of pyrites. The domestic mines show larger quantities mined than in the previous year, and they are also opening and developing the ground and works to such an extent that a scarcity is impossible.

There have been no new pyrites mines opened in the United States in 1885 where the product has sought a market with the acid makers. The mines already developed have increased their output sufficiently to supply the additional demand. Stocks of pyrites have not unduly accumulated at the mines, the owners preferring not to mine more ore than the trade demands. At all of these mines, however, the machinery has been greatly augmented, and the work of development has been driven ahead of the present requirements. The machinery and equipments are of the most improved and modern patterns. It is believed that there are few mines in the United States where the machinery is of a better type, or where the average cost of mining is as low per ton of dressed ore, as at those of the different pyrites companies. The facilities for transportation have been greatly improved, and by the end of 1886 the leading companies will have direct railway connections with the mines.

### PREPARATION OF ORE.

The American consumer requires that the ore be prepared for him of the proper size for the furnace, before shipment. In fact, this is a great advantage to the consumer, as he thereby obviates the necessity for the outlay of money for a crusher, engine, etc., and the more annoying expenses attending their operation. He also escapes the loss in the nut-size ore, which is made to the extent of about 5 per cent. of the whole, and which is too small for grate, and too large for small furnaces without crushing.

Consumers can now purchase their ore of any domestic producer, broken to the proper size for their grate furnaces (not larger than 3 inches or smaller than 1 inch in diameter) or the smalls screened through a one-fourth inch mesh screen for their smalls furnaces, these sizes being best adapted for perfect and rapid burning and leaving nothing that will not go through the furnace with good results.

This matter of breaking has heretofore been an unknown quantity to the acid maker, and one on which he had no basis for costs, which, taken with the resulting fines and intermediate sizes which he could not use, has prevented his adopting pyrites until he could see his way more clearly. This he can now do by buying exactly the size he wishes to use.

At one time it looked as if the price of brimstone would gauge the price of pyrites, but this has been found not to be the case. The cost of pyrites acid is so much less than that made from brimstone that they have never actually been in competition. Sulphuric acid, for certain purposes, will probably always be made from brimstone, but the large bulk of acid must naturally be made from the cheaper material. That the present prices will be maintained is not certain, the tendency naturally being for the miners of domestic pyrites to hold the trade if possible against foreign competition. Miners working on a large scale and able to sell all their output, can produce ore at a lower cost than when obliged to be idle part of the year, or to stock large quantities, requiring special capital and entailing additional expense in handling, whereby more or less loss is occasioned. The economy is much greater if the ore is shipped to the consumer as fast as it comes from the mine.

### DAILY SAMPLING AND TESTING.

The daily drawing and testing of samples is not considered of sufficient importance to pay for the labor and expense, and it is only by some accident that imperfect and wasteful burning is discovered. Even when discovered it is only partially remedied. In drawing samples of cinder for a test it is quite essential that samples from separate furnaces should

be drawn, as well as a thoroughly mixed sample of the whole. In this way those furnaces doing well or ill can be noted, marked, and watched day by day until all are as nearly perfect as possible. It is a mistake to suppose that any ignorant laborer is competent to burn pyrites after a few days' teaching, but the fact that any result regularly under 10 per cent. is not considered sufficiently bad work to call for investigation and correction by the manager, will account for the supposition. It is just as easy to do good as bad work in burning pyrites, and a month's average should not show over 5 per cent. sulphur left in the cinder, and even this can be improved upon. One thing is certain: if the cinder contains over 5 per cent. on a month's average, there is something wrong, and some one is incompetent, or not attending to his duties. The following rapid and reliable method of testing cinder is in daily use in one of the leading chemical works in England, and its accuracy can be relied upon:

ESTIMATION OF SULPHUR IN PYRITES CINDERS.

*Reagents used.*—(1) Semi-normal solution of sulphuric acid 1 cubic centimeter = .0245 grm., $H_2SO_4$ = .0155 grm., $Na_2O$ = .008 grm. S.

(2) Bicarbonate of soda, the standard acid value of which is determined each time the reagent bottle is refilled, by titrating 3.2 grms. with the standard acid. Generally about 77 cubic centimeters ÷ 2 = 38.5 cubic centimeters per 1.6 grms.

*Process.*—Two grams of the very finely powdered sample of cinder and four grams of the bicarbonate of soda are carefully mixed in a porcelain crucible and heated to dull redness over a Bunsen burner for about forty minutes, with occasional stirring. The contents of the crucible are now washed into a 250 cubic centimeter flask, made up to the mark with boiling water, emptied into a beaker and well stirred; then allowed to settle for a minute or two, and a quantity of the supernatant liquid passed through a dry filter; 100 cubic centimeters of the clear filtrate are measured into a beaker, cooled and titrated with semi-normal sulphuric acid solution, using methyl orange as indicator.

Suppose 35 cubic centimeters required:

| | |
|---|---|
| c. c. $\frac{n}{2}$ acid required for 1.6 grms. bicarbonate of soda..... | 38. 5 |
| c. c. $\frac{n}{2}$ acid required for 100 cubic centimeters filtrate..... | 35. 0 |
| Difference = percentage sulphur in cinder ..... | 3. 5 |

By the above process a test can be completed in an hour, and six (or more) samples can be finished in an hour and a quarter. The results are almost identical with those obtained by oxidation with nitro-hydrochloric acid and precipitation with barium chloride. The only point requiring special care is the heating over the Bunsen burner (or spirit lamp). But as long as a dull red heat is not exceeded there is no danger of loss of sulphur, unless the amount in the cinder is very high. Con-

stant stirring is not necessary, so that the operator can carry on other work while this is going on. Observe that the percentage of sulphur found in a given quantity of cinder is not the same percentage as on raw pyrites.

Pyrites loses in burning from 20 to 35 per cent. of its weight, after allowing for the absorption of oxygen. One hundred pounds of siliceous ore, containing 4 per cent. copper, will weigh, after burning, about 80 pounds, while a cinder of nearly pure pyrites, low in silica and copper, will weigh about 70 pounds. Hence, if the sulphur in the cinder of the latter is found to be 5 per cent., it will be on the basis of raw pyrites, 3.5 per cent.

### CUPRIFEROUS PYRITES CINDER.

A novel and ingenious method of treating cupriferous pyrites cinder has recently been adopted. The copper mattes from siliceous ores are broken to the required fineness and mixed with ordinary pyrites cinder low in silica, and are then treated by the Henderson process, the copper and silver being saved as usual by the wet method. This is comparatively an inexpensive way of saving the silver in the matte, and the residue is a merchantable purple ore, worth several dollars per ton.

### ORDINARY IRON PYRITES RESIDUE.

At present, in the United States, not less than 40,000 tons annually of cinder from pyrites are thrown away or used for filling. The average contents are:

*Analysis of ordinary pyrites residue.*

| | Per cent. |
|---|---|
| Peroxide of iron | 88.00 |
| Sulphur | 5.00 |
| Silica and insoluble matter | 4 50 |
| Lime | 1 00 |
| Copper | 1.50 |
| Total | 100.00 |

It is safe to say that all of this cinder carries fully 60 per cent. metallic iron and is free from phosphorus.

The use of commercial acid comprises only about 10 per cent. of all the acid consumed, the remainder being used for fertilizers and oil refining. If the use of pyrites should become general for the purposes for which it is as well adapted as brimstone, the direct annual saving to the manufacturer would be, basing the present consumption of brimstone for acid making at 90,000 tons, $630,000, a difference of $7 per ton in favor of pyrites.

There has been great reluctance on the part of acid makers to allow the quantities of pyrites used, or acid produced therefrom, to be published

in connection with their works; the quantity has therefore been given in the aggregate. The amount was arrived at by the number and kinds of furnaces in use, and taking their capacity. Due allowance has been made for stoppages.

### INCREASED USE OF SULPHURIC ACID.

By reference to the table of imports we find that in 1884 upwards of 105,000 tons of brimstone were imported, and in 1885 nearly the same. Most of this was consumed, leaving the 91,400 tons of pyrites as showing the natural increase of sulphuric acid used. The average of brimstone imports for the past five years is slightly over 100,000 tons, showing an increase since 1878 of over 100 per cent. Reducing the consumption of pyrites for 1885 to its equivalent in brimstone gives, in round numbers, 42,000 tons. This added to the brimstone shows an increase of over 300 per cent. since 1878.

### FURNACES.

During the past year the majority of the new furnaces built have been for burning smalls ore, the Spence mechanical and ordinary shelf-burner being the styles adopted. The double Spence furnace can be erected for about $3,800, exclusive of labor, and requires 20 cubic feet of chamber space to 1 pound of sulphur burnt off. It will burn 60,000 pounds of 48 per cent. ore per week, without undue escape of fumes.

### RAW MATERIALS FOR THE MANUFACTURE OF SULPHURIC ACID.

*Iron pyrites as bisulphide of iron.*—There are few minerals which are found in such profusion and abundance as iron pyrites. It often occurs in bodies of large extent, laterally and in depth. Pyrites to be of value for making sulphuric acid must be the bisulphide of iron. This when pure is of the following composition:

*Typical composition of iron bisulphide.*

| | Per cent. |
|---|---|
| Sulphur | 53.30 |
| Iron | 46.70 |
| Total | 100.00 |

When silica, copper, zinc, and some other minerals form a part of the combination, the sulphur and iron are reduced in proportion, but so long as the combination is a bisulphide, the burning qualities are but slightly affected. Of course if the sulphur contents are reduced, a larger quantity of pyrites must be handled to obtain the same amount of sulphur—this also at an additional expense of time and extra loss in cinder.

*Pyrrhotite or magnetic pyrites.*—A great part of the deposits of pyrites are the magnetic or pyrrhotite varieties, of which the following is the composition:

*Typical composition of pyrrhotite.*

| | Per cent. |
|---|---|
| Sulphur | 39.50 |
| Iron | 60.50 |
| Total | 100.00 |

It varies from $Fe_7S_8$ to $Fe_{10}S_{11}$ and is never a true protosulphide. Possibly this may account for its reluctance in parting with its sulphur. These varieties are worse than useless for acid making, for not only is the sulphur in less quantity in the pyrites, but the combination is of such a nature that it will not readily give up its sulphur. It has thus far been found impracticable to burn these ores and utilize the gas for acid making. The sulphur can be burned off when placed in piles in the open air, assisted by a liberal quantity of wood, thereby preparing it for copper smelting; but in kilns it has invariably been found either to become cold and dead, or so hot as to melt into a solid mass in the furnace. Many thousands of dollars have been lost in trying these experiments, and failure has been the invariable result.

*Marcasite* is sometimes used as a raw material for making acid. Its composition is represented by $FeS_2$, the same as ordinary pyrites. It is usually found in bituminous slate and coal, but not often in sufficient quantity to pay for mining.

*Zincblende* (*sphalerite*) is also used as a raw material, but usually only preparatory to further metallurgical treatment. The sulphur in zincblende does not burn readily, and the calcining must be finished in a reverberatory furnace. A mixture of blende and pyrites is sometimes utilized.

*Galena* cannot be used for acid making, as it parts with its sulphur, only at a strong white heat.

*Matte.*—The sulphur in mattes is often saved for acid making, generally where the noxious vapors are not permitted by law to escape into the atmosphere.

*Sulphur from coal gas.*—Spent oxides from the purification of coal gas are also used to some extent under favorable conditions.

*Mispickel or arsenical pyrites* is too low in sulphur contents to be of value, even if the arsenic did not prevent its use.

*Auriferous pyrites.*—The auriferous pyrites of the Rocky mountains and the far West are destined to bear an important part in the gold production of the United States. Almost all the pyrites in this section carry gold in paying quantities. Where the pyrites are found as bi-sulphides there can be no question that with close concentration they would be available as a raw material for making sulphuric acid. One ton of

concentrates containing 40 per cent. sulphur would produce one ton of sulphuric acid of 66° Baumé, worth in some parts of the West not less than $50. If the pyrites is in the form of troilite, which, unlike pyrrhotite, is a true protosulphide, there is little doubt that it could, if in sufficient quantity, be made available for making sulphuric acid.

Troilite when pure contains:

*Typical composition of troilite.*

| | Per cent. |
|---|---|
| Sulphur | 36.36 |
| Iron | 63.64 |
| Total | 100.00 |

If 25 per cent. of the sulphur could be saved as sulphurous acid, 1,500 pounds of 66° acid could be made from one ton of concentrates. The acid would be very valuable for generating chlorine for chloridizing ores, and would make many otherwise worthless ores pay handsome profits. The expense of a plant to make 10 or 15 tons of acid per day would not be excessive.

# MICA.

New mica deposits have been found in Franklin and Cleveland counties, North Carolina; in the latter there are ten new mines said to be of good quality and unusually extensive. In Pennsylvania a new mine has been opened on South mountain near Newmanstown, and will probably be a source of supply during 1886. Several mines have been added to those in the neighborhood of Groton, New Hampshire, and a mining company has begun operations in Nashua in the same State. The principal yield in New Hampshire was from the Valencia mine in Groton. The property here comprises 300 acres, only a very small part of which has been opened, although the mine has been worked since 1883, with a force of about 55 men in winter and 75 in summer. The yield increased to 29,000 pounds in 1885. In the Black Hills mining has been suspended, and those well posted on the subject have failed to find a single mine which produced any mica during 1885. In Colorado a vein of mica was found about 65 miles from Pueblo. It is 5½ feet wide, lying in white quartz, and has been traced for 3,000 feet. Mica of good quality and in large sheets has also been reported from the neighborhood of Fort Collins. The Denver Mica Company after a short trial run ceased mining and cutting mica. The sheets available were too small, and the business was entirely unremunerative. In Wyoming, Idaho, and Montana, nothing of interest has been noted except the location of a new mine about 9 miles from Rockford, in Spokane county, Wyoming. Specimens from this mine seem unusually clear. In New Mexico work has been steadily prosecuted at the Cribbensville mines, at Petaca in Rio Arriba county. Here the mica occurs in the general mass of eruptive granite, the quartz, mica, and feldspar being seggregated into masses. Fluorspar is noted as occurring with the mica, which is found in pockets or masses having a general northwest course. The mica-producing belt is about 14 miles long by 4 miles wide. The mica is clear, tough, and of an olive-green to gray-green color. The largest sheet yet cut was 12 by 14 inches in size, but the average size is 3 by 5½ inches. It is sent direct to the factory of the owners in Chicago. During 1885, 12,000 cubic feet of rock were excavated and 20 tons of mica taken out, of which 2,000 pounds were salable, showing a yield of 5 per cent. good mica. The mine is worked regularly.

Mica is an abundant mineral in all the Pacific States and Territories. Mr. C. G. Yale states, however, that it has been mined only in a few places and nowhere with results that have led to a long continuance

of the business. The deposit of mica discovered in the Salmon mountain, Siskiyou county, California, and alluded to in the last volume of the "Mineral Resources of the United States," has been worked to some extent since; but it produced little marketable mica and work has been suspended upon it. Most of the mica found is of a stained or impure character, though in some deposits very large clear sheets are obtained. Even with good quality, however, no market for it has been found. In explanation of the condition and prospects of the industry in that region the following is quoted from the fourth annual report of Mr. Henry G. Hanks, State mineralogist of California:

"Mica, in sheets or plates of the size and quality that adapt it for the uses to which it is mostly applied, is a mineral that can be mined with profit where the conditions are favorable. Nevertheless, much misapprehension seems to exist among miners as to the requirements of the trade and the prices usually paid for this mineral; the idea having obtained among this class that mica is so scarce and in such demand that there is always a market for it at extravagantly high figures. But this is a mistake; it is only sheets of superior quality and extra large size, such as are rarely found, that meet with ready sale at high prices. Owing to the erroneous notions entertained on this point, the several attempts that have been made at working the mica deposits of California and Nevada have resulted in disappointment and loss, the parties who engaged in these enterprises having failed to realize for their product such prices as they had counted upon, chiefly because it did not quite meet the wants of purchasers. The outlook for this industry is, however, by no means desperate, as there are many promising deposits of mica in California, and elsewhere on the coast, and there is a chance that the quality of the article will improve when the mines come to be opened to greater depths."

*Production.*—In 1885 the production of mica amounted to about 92,000 pounds, valued at $161,000. The decrease from 147,410 pounds in 1884 was due to suspension of western mining, and also to a decrease in North Carolina.

The production for 1884 and 1885 may be divided as follows:

*Production of mica in* 1884 *and* 1885.

| | 1884. | 1885. |
|---|---|---|
| | *Pounds.* | *Pounds.* |
| North Carolina | 100,000 | 60,000 |
| Valencia mine, New Hampshire | 25,000 | 29,000 |
| Other mines in New Hampshire | 3,260 | 1,000 |
| Cribbensville mines, New Mexico | 1,000 | 2,000 |
| Black Hills | 18,150 | ..... |
| Total | 147,410 | 92,000 |

Estimated total production since 1882:

| Years. | Pounds. | Value. |
|---|---|---|
| 1882 | 100,000 | $250,000 |
| 1883 | 114,000 | 285,000 |
| 1884 | 147,410 | 368,525 |
| 1885 | 92,000 | 161,000 |

*Prices.*—The fact that fine, large sheets of mica have a value of several dollars per pound, reaching in exceptional cases as much as $10 per pound for special pieces, has led to popular misaprehension in regard to the average value of this mineral. In the West, particularly, mica has been sold at from $3 to $4.50 per pound on which the price has since been reduced below the limits of profitable mining. The average for 1885 may be put at $1.75 per pound. The mica from North Carolina is best in quality and demands the highest price. That from New Hampshire ranks next in quality, while that in the West has come to be regarded as poorest, and the price has fallen in many instances to $1.25 per pound.

The imports of manufactured mica recently have been:

*Unmanufactured mica imported and entered for consumption in the United States,* 1869 *to* 1885, *inclusive.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1869 | $1,165 | 1878 | $7,930 |
| 1870 | 226 | 1870 | 9,274 |
| 1871 | 1,460 | 1880 | 12,562 |
| 1872 | 1,002 | 1881 | 5,839 |
| 1873 | 498 | 1882 | 5,175 |
| 1874 | 1,204 | 1883 | 9,884 |
| 1875 | | 1884 | 28,284 |
| 1876 | 569 | 1885 | 28,685 |
| 1877 | 13,085 | | |

# ASBESTUS.

There was very slight production of asbestus during the past year, owing to the competition of Canadian producers, who have extended their facilities of mining. They are also connected with the principal manufacturers in this country in such a way as to make it comparatively easy for them to dispose of their material in New York and Boston.

The Asbestus Felting Works have estimated the production of asbestus in the United States at 300 short tons during 1885, valued at $15 to $50 per ton, as taken from the ground. The attempt will possibly be made to mine a deposit recently opened in northern Georgia, when transportation facilities admit. An attempt is being made to mine asbestus in Windsor, Sonoma county, California.

Besides the localities already mentioned in the former reports of this series, asbestus has been found in Del Norte and Yolo counties, California. Some of these deposits appear to be better in quality than any others in the State, and the quality it improves with the depth. There is plenty of asbestus in California for manufacturing purposes which could probably be delivered in San Francisco for $35 per ton, but the demand for the products is not sufficient to justify large mining operations. There is one factory in San Francisco which produces asbestus paint, coating for steam boilers and pipes, packing for engines, and asbestus for roofing and like purposes.

*Foreign sources.*—The importations, particularly from Canada, increased during the past year. The Canadian mines are located in Thetford and Coleraine townships, Quebec. The total production in Canada during 1885 was 1,800 short tons, with an average value of $70 per ton. It has only been possible to work the mines from April 15 to November 15 of each year. The new mine at Gundagai, in New South Wales, is likely to enter the market not only as a source of crude, but of manufactured asbestus.

*Value of asbestus imported and entered for consumption in the United States, 1869 to 1885 inclusive.*

| Fiscal years ending June 30— | Unmanufactured. | Manufactured. | Total. |
|---|---|---|---|
| 1869 | ..... | $310 | $310 |
| 1870 | ..... | 7 | 7 |
| 1871 | ..... | 12 | 12 |
| 1872 | ..... | ..... | ..... |
| 1873 | $18 | ..... | 18 |
| 1874 | 152 | ..... | 152 |
| 1875 | 4,706 | 1,077 | 5,783 |
| 1876 | 5,485 | 396 | 5,881 |
| 1877 | 1,671 | 1,550 | 3,221 |
| 1878 | 3,536 | 372 | 3,908 |
| 1879 | 3,204 | 4,624 | 7,828 |
| 1880 | 9,736 | ..... | 9,736 |
| 1881 | 27,717 | 69 | 27,786 |
| 1882 | 15,235 | 504 | 15,739 |
| 1883 | 24,369 | 243 | 24,612 |
| 1884 | 48,755 | 1,185 | 49,940 |
| 1885 | 69,489 | 248 | 69,737 |

*Domestic exports of manufactured asbestus.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1879 | $2,335 | 1883 | $17,865 |
| 1880 | 7,848 | 1884 | 30,846 |
| 1881 | 30,785 | 1885 | ..... |
| 1882 | 18,923 | | |

*Uses.*—Although little asbestus was mined during 1885 in the United States, it has been manufactured here into various useful forms. There are many substances which have assumed industrial importance because of their inability to burn, and being also such poor conductors of heat as to protect other material from fire; but asbestus has the additional advantage of fibrous structure which admits its use for fire-proof fabrics.

Of these there are many which would be more useful if fire proof, and although even the best asbestus is somewhat brittle, there are enough fabrics, such as theater curtains and, particularly, asbestus filtering cloth, to give a market value of $100 to $500 for Italian asbestus, which is best suited for weaving. The principal use for asbestus is for packing steam joints and others where a high temperature is attained. For this purpose it is made into millboards and rope, and is much superior to any other packing. The use of asbestus as a non-conducting covering for boilers has increased markedly during 1885. This is the most interesting use to which it has been put, for the sheathing can be made of the cheap variety of asbestus common in this country. It is probable also that the use of asbestus cloth for filter bags in sugar refineries will follow the lead of the French, Austrian, and German refineries.

# ELDSPAR.

By William C. Day.

*Occurrence.*—Since the publication of the last report on feldspar in "Mineral Resources of the United States, 1883 and 1884," orthoclase, the only variety of feldspar used in the arts, has been discovered in the following localities:

At Embreville, on the Wilmington and Northern railroad, Chester county, Pennsylvania, a deposit has recently been opened which reveals good prospects both as regards quality and quantity, but, as yet, developments have been insufficient to allow anything further to be said.

Samples of orthoclase of fine quality have been taken from a deposit in the neighborhood of Ishpeming, Michigan.

In Missouri, on the Iron Mountain railroad, some distance southwest of Saint Louis, a good deposit is said to exist.

The only deposit thus far found on the Pacific coast was recently discovered in Tehachapi cañon, Kern county, California. The extent of this deposit is not known, but the quality is said to be very fine, and, if sufficiently abundant, the mineral could be profitably worked and shipped to market on account of its close proximity to the Southern Pacific railroad.

*Production.*—Two of the most prominent pottery manufacturers independently estimated the total consumption of feldspar in the United States at 10,000 long tons in 1885. Detailed returns from producers and consumers give 13,600 as the exact production, leaving some stock on hand at the end of the year.

*Production of feldspar in* 1883, 1884, *and* 1885.

| States. | 1883. | 1884. | 1885. |
|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* |
| Maine | 3,200 | 900 | 2,500 |
| Connecticut | 6,000 | 6,000 | 4,500 |
| Massachusetts | 500 | 500 | 1,000 |
| New York | 500 | 500 | 2,000 |
| Delaware | 900 | 1,000 | 2,250 |
| Pennsylvania | 3,000 | 2,000 | 1,350 |
| Total | 14,100 | 10,900 | 13,600 |

*Value.*—Crude feldspar is valued at $5 per long ton. Pulverized feldspar is valued at $11 per ton in Trenton, New Jersey, and $12 per ton in East Liverpool, Ohio, in which places most of the mineral is used.

# MINERAL PAINTS.

By Marcus Benjamin.

*White lead.*—The number of white-lead corroders has been increased during 1885 to thirty-three, by the establishment of works at Pittsburgh, and at New York City. It is estimated that 60,000 short tons of white lead were produced during the year. The price is higher, and from $4\frac{3}{4}$ to $5\frac{3}{4}$ cents per pound is asked for the dry pigment; ground in oil it brings one-half cent per pound more. The imports at New York during the year were 622,924 pounds.

*Litharge and red lead.*—In consequence of the advance in price of pig lead these pigments are sold at about one-fourth cent per pound higher than in the preceding year.

*Orange mineral* is an oxide of lead made by throwing white lead on the hearth of a reverberatory furnace. The carbon dioxide is expelled and the lead oxide remains behind. This color is extensively used as a base, with which eosine and similar aniline colors are mixed to produce an artificial vermilion. It is worth from $7\frac{1}{4}$ to 8 cents per pound. Orange mineral is made by a number of the corroders, and it is also imported.

*Zinc white.*—This pigment continues to be made directly from the ore by the zinc works in the United States (see page 921 of "Mineral Resources for 1883 and 1884," and pages 358–386 of the 1882 report). The production of the different companies is estimated to have been about 15,000 short tons, of which two-thirds was consumed by the paint trade. The price of this pigment remains at 3 to 4 cents, according to the quality. There are at present three brands of zinc white imported into the United States, the most important of which is the French or Veille Montagne, and it is estimated that 7,000 casks (of 220 pounds each) of this brand were imported during 1885. Of the "B. and S." brand, which is said to be finer than the French, and which commands a slightly higher price, some 2,300 casks, or 508,300 pounds, were received from Germany at New York during the past year; while 1,500 casks, or 330,000 pounds, of the German "L. Z. O." brand were imported during the same time. The total importations of zinc oxide at New York during 1885 amounted to 2,364,561 pounds.

*Barytes.*—The eastern demand for barytes is largely supplied by Burgess & Newton, of New Haven, Connecticut. The crude material used by this firm is entirely imported, mostly from Germany. During 1885 about 4,000 short tons were received by them, costing from $7 to

$8 per ton at the port of entry. Only the very highest grade of barytes, perfectly free from quartz or lime, and testing 99.50 per cent. pure barium sulphate, is ground; and, as it is perfectly clean, no sorting is required. The mineral is first crushed, then washed, and conveyed into vats, where it is thoroughly heated, and then sulphuric acid is added, after which it is steamed until all impurities and stains are eaten away. The process extends over thirty-six hours, for after the steaming the mineral is allowed to stand and "cook." The acid is then drawn off and the barytes thoroughly cleansed by several washings with pure water. It is then dried and sent to the mills for grinding. Finally it is barreled, ready for delivery. The price during the current year was from $18.50 to $21.50, according to quantity, delivered in New York.

Tanner, Bliss & Co., of Lynchburg, Virginia, grind barytes mined at several localities in Virginia. The process employed is similar to the one previously described, and the annual output from this source is about 3,000 tons, which sells in New York at prices ranging from $18 to $20 per ton, according to quantity. An "off-color" barytes, worth from $12 to $14 per ton, is likewise on the market, and is used principally in the mixing of colored paints.

The Page & Krausse Manufacturing and Mining Company, of Saint Louis, Missouri, obtained from deposits at and around Cadet and Potosi, Washington county, Missouri, about 3,000 tons of barytes during 1885, having a value of from $4.50 to $5.50 per ton on the cars at the localities mentioned. There are also mines in Cole, Franklin, Jefferson, and Maries counties, in the same State, that have not yet been properly opened or fully developed, from which the above firm received 1,000 tons during 1885. The process of manufacture is as follows: The crude mineral is first sorted and cleaned; then it is crushed or broken into pieces about the size of the tip of a finger. Next it is refined and purified by boiling in acid until the impurities are entirely removed; after which it is boiled in distilled water, then dried by steam, and finally ground in mills until every particle of coarse material has disappeared. This refined product sells in New York at from $26 to $27.50 per ton, according to quantity. The "floated barytes" is further treated by being mixed with water and run through troughs or sluice ways into a large receiving vat, whence it is taken, again dried by steam, and, lastly, barreled. The "cream floated" is quoted in New York at from $32 to $32.50 per ton, according to quantity. The greater portion of this company's output is consumed by paint makers. A mixture consisting of 60 parts of zinc oxide and 40 parts of cream-floated barytes is recommended by them as forming a good and very durable paint. Their product is likewise bought by ham curers or pork packers, who use it in canvasing hams to stop the meshes of the canvas with a view to stopping the ingress of insects and air.

The Pittsylvania Milling and Mining Company, of Warm Springs, North Carolina, grind and sell barytes, but their sources of supply and output have not been reported.

*Terra alba.*—The gypsum which is ground to produce this material is all imported. Two grades exist, known as No. 1, mined at Hillsboro, Canada, and worth laid down in New York from $5 to $7 per ton; and No. 2, mined at Windsor, Nova Scotia, valued at $3 to $3.50. The crude mineral is ground at New York by the Phœnix Plaster Mills, and at Newburg by the Newburg Plaster Works. The terra alba is worth from $14 to $15 per ton for No. 1, and from $8 to $10 per ton for No. 2. It is impossible to estimate the amount of this substance used by paint manufacturers, for the reason that sales are chiefly made through brokers who handle the product for the works. A finer grade of terra alba is imported from France, and a very small quantity from England. It is worth from $15 to $16 per ton on the dock in New York.

*Whiting.*—During 1885 there were imported 105,280,000 pounds of chalk into the United States. Of this amount 71,680,000 pounds were received at New York and 33,600,000 pounds at Philadelphia. At these two cities it is ground into whiting. The price of the common grade of whiting has advanced and it is now quoted at 40 to 45 cents per hundredweight. Whiting is used by the manufacturers of calcimine, rubber, wall paper, picture-frame moldings, oilcloth, and paints, and by potters. The sales during 1885 aggregated 275,000 barrels, having an average weight of about 340 pounds.

*Paris white.*—There were imported into the United States during 1885 13,492,800 pounds of cliffstone, which was ground into Paris white; 347,000 pounds of Paris white manufactured abroad were also imported during the same time. The present selling price is from $1 to $1.25 per hundredweight. Paris white is used in the same manufactures, excepting those of picture-frame molding, but not so extensively as whiting, and the consumption during 1885 is estimated at 12,400,000 pounds.

*Ultramarine.*—The production of ultramarine in the United States during 1885 was slightly diminished by the partial burning of the American Ultramarine Works at Newark, New Jersey. The exact output from this factory has not been obtained, but it is estimated to have been not less than 1,000 tons. The Germania Ultramarine Works, at Whitestone, Long Island, produced 857,816 pounds. A plant known as the International Ultramarine Works was established during 1885 at Roseville, New Jersey, but its product was not placed on the market during the year. The prejudice which formerly existed against American ultramarine has been reduced steadily, and at present the domestic brands compete very successfully with the foreign.

*Ocher.*—This is a term familiarly applied to a well-known pigment, varying in color from a light yellow to a deep orange or brown, and con-

sisting of iron peroxide and water, with varying proportions of clay in a state of impalpable subdivision. Strictly speaking, ocher is a hydrated peroxide of iron consisting of about 80 per cent. peroxide and 20 of water, but it is very rarely found absolutely pure and appears to be a product of decomposition. The foregoing definition, taken from David Page's "Handbook of Geological Terms," is given in order that an exact scientific explanation of the term may be had before its trade significance is mentioned. In commerce the word ocher is applied to the lighter yellow earths containing iron peroxide, and the term "metallic paint" is used to designate the brown and darker shades. As the information here presented has been obtained from commercial sources this classification will be used. Ochers may be divided into common ochers, medium ochers, and high grade imported ochers.

*Common ocher.*—This grade of material is largely mined in Maryland, Pennsylvania, and Vermont. It has a value of from $10 to $15 per ton, and is entirely consumed by floor-cloth manufacturers. It is used by them in the preparation of the body of the cloth, and has no value as a pigment on account of its dull color.

*Medium ocher.*—This grade includes the French ochers and the best class of ochers produced in this country. The consumption of this material aggregates about 3,000 tons per annum, having a value of from 1 cent to 1½ cents per pound.

*High grade ocher.*—This grade is principally used by paint grinders. Owing to its strength, as it contains a large amount of iron, only a small quantity of oil is required in mixing; hence it can be made into a profitable paint. The consumption is about 1,000 tons per annum, and the value is from 2 to 3½ cents per pound. The principal American producers of ocher are the Bermuda Ocher Company, the Oxford Ocher Company, Henry Erwin, and the Franco-American Mining and Ocher Company, all of New York.

The Bermuda Ocher Company has a deposit on the north bank of the Appomattox, in Chesterfield county, Virginia, near Bermuda Hundred. The crude ocher is washed, dried, and then ground into an article which in fineness of quality and in adaptation to all the purposes for which a light-yellow ocher is used, is unexcelled by that from any other deposit known in this country. Three grades are made, all of the same tint but of different degrees of fineness, namely, single washed, double washed, and extra floated. At the shipping point in Virginia these grades have a value, respectively, of $18, $21, and $27 per ton. To this price must be added the freight to the locality at which the ocher is to be used. This company has facilities for mining and manufacturing 2,500 to 3,000 tons of ocher per annum, an amount sufficient to supply the entire trade of the United States with this grade of material; but the output during 1885 did not exceed 1,000 tons.

The Oxford Ocher Company mines an ocher near Marksville, in the

Shenandoah valley, Virginia, which has approximately the following composition:

*Analysis of ocher mined near Marksville, Virginia.*

| | Per cent. |
|---|---|
| Iron peroxide | 39.0 |
| Alumina | 15.0 |
| Silica | 33.0 |
| Potash and other alkalies | .5 |
| Water | 11.5 |
| Total | 99.0 |

The output of this company during 1885 was between 800 and 1,000 tons, having a value in its crude condition at the mine of $15 per ton. Ground and barreled, it sells at New York at $20 per ton.

These ochers from Virginia are considered fully equal to the foreign brands sold in the United States under the trade names of "Havre" and "Rochelle."

The deposits marketed by Henry Erwin are located in the vicinity of Bethlehem, Pennsylvania. The ore includes all grades. It is estimated that the output during 1885 was between 1,500 and 2,000 tons. The crude material is washed, floated, and then ground. Its average value on the cars at Bethlehem is stated to be $10 per ton. A so-called "Bonne Fortune" ocher has recently been discovered near Bethlehem, which is said to have a greater strength than the standard French ochers. This material, when washed, floated, and dried, commands $40 per ton. A steadily increasing demand is said to exist for this new American variety of high grade ocher.

The Franco-American Mining and Ocher Company owns several deposits of an excellent grade of ocher. One of the mines is located in Scott county, Missouri, about 160 miles south of Saint Louis, from which, during 1885, 500 tons of the crude material were shipped to New York, where it was ground and made into the dry pigment. Other deposits of high grade ochers are said to exist in the vicinity of Saint Louis, but no definite information as to their character has been received.

A so-called "Peruvian" ocher is found in deposits between strata of iron and manganese ore in Fulton county, near Atlanta, Georgia, of which some 300 tons were mined during 1885. It is ground, washed, dried, and then sent to New York. The prepared pigment is said to contain from 85 to 90 per cent. of iron peroxide and is worth from $70 to $80 per ton in New York. This deposit, although small, is said to yield a product superior to any that is imported. The American ocher, while identical in chemical composition with the French, seems to exist in a different state of combination. The silica in the imported ocher appears to be free, while in American ocher it is chemically combined with the alumina, forming a clay. American ochers are doubtless finer, but most of them require more oil for grinding, and hence the paint

produced is more expensive, as oil is worth 7 cents per pound, and the ocher only about 1½ cents. The free silica of the French ocher causes it to work more freely, and it also imparts to the pigment the valuable property of catching and holding to the fibers of wood, thus acting as a filler.

*Imported ochers.*—These are obtained principally from France. The "Rochelle" ochers are mined near Neuvy-sur-Loire, a small village on the railroad to Lyons, about 100 miles south of Paris. The "N. M. B." brand is the one best known in this country. The crude ocher is placed in drying houses similar in construction to those used for drying whiting; when sufficiently dry it is ground in buhr mills, bolted, and packed in casks for shipment. The spot value of this ocher was, in 1877, 1½ francs per 200 kilos (440 pounds) at the mouth of the shaft. During 1885 2,500 casks of 750 pounds each were imported at New York. It sells at from 1.32½ to 1.35 cents per pound in quantity. The "Auxerre" ochers, mined in the same district, contain a larger percentage of iron; they are darker in color and require to be washed. During 1885 about 2,000 casks of 750 pounds each of this variety of ocher were received at New York. It is of a higher grade than the "N. M. B.," and sells at 1¾ to 3½ cents per pound. The "Havre" ocher, which formerly met with considerable sale, is now in slight demand, owing to the amount of sand contained by it. Fine ochers are found in England, Germany, and Italy, but in amount trifling in comparison with the French product. From England there is annually imported from 1,500 to 2,000 tons of a red coloring substance, variously known as oxide of iron, colcothar, crocus, and crocus martis, most of which is used by paint manufacturers; 600 tons are consumed by the paper trade, and it is also used as a polishing material. It is principally mined in the Forest of Dean, in South Wales, and at localities near Bristol, England. The crude material contains as much as one-third moisture, and therefore it is generally calcined before it is sold.

*Metallic paint.*—Under this title there will be considered, the products manufactured by the Prince Manufacturing Company, Lowe's Metallic Paint Company, the Ironclad Paint Company, and F. W. Devoe & Co.

The Prince Manufacturing Company, of New York, sells a metallic paint which is made from a blue magnetic iron ore, containing about 50 per cent. of iron peroxide, 25 per cent. limestone, and 25 per cent. sulphur. It is mined in Carbon county, Pennsylvania, and the output during 1885 was some 3,000 tons, worth, in its crude condition, about $10 per ton. The ore is broken into small pieces, roasted, and then ground. During this process it loses one-third of its weight by the volatilization of the sulphur and other constituents, so that only 2,000 tons of the refined product were shipped from the works during the past year. The prepared pigment is said to contain 72 per cent. of iron peroxide and 28 per cent. of hydraulic cement. It is mixed with oil and one color (brown) only is made. This paint is principally recom-

mended as an indestructible coating for iron, tin, and wood. It likewise finds application in the manufacture of linoleum, oilcloth, and floor cloth. The dry pigment is sold in New York at from $25 to $27.50 per ton.

Lowe's metallic paint, manufactured at Chattanooga, Tennessee, is made from red fossiliferous iron ore mined at Atalla, Alabama, and at Ooltewah, Tennessee. An analysis of the paint shows its composition to be:

*Analysis of Lowe's metallic paint.*

| | Per cent. |
|---|---|
| Iron peroxide | 78 87 |
| Alumina | 3. 29 |
| Silica | 11. 96 |
| Water | 5. 07 |
| Phosphoric acid, lime, manganese, etc. | . 80 |
| Total | 99. 99 |

The crude ore is valued at $2 per ton at the mine, and 2,000 tons are annually ground into pigment. The mineral is crushed, then spread on steam pans and thoroughly dried, passed through buhr mills, bolted, and finally re-ground. The finished product is worth, barreled, $20 per ton at New York.

The Ironclad Paint Company, of Cleveland, Ohio, manufactures four varieties of mineral pigments. No. 1, called "Rossie red," is made from ore mined in Wayne county, New York, and has the following composition:

*Analysis of No. 1.*

| | Per cent. |
|---|---|
| Iron peroxide | 60. 50 |
| Alumina | 5. 63 |
| Calcium carbonate | 15. 66 |
| Silica | 18. 00 |
| Moisture | . 33 |
| Total | 100. 12 |

No. 2, or "light brown," is prepared from an ore mined in the iron district of Lake Superior, Michigan.

*Analysis of No. 2.*

| | Per cent. |
|---|---|
| Iron peroxide | 77. 26 |
| Alumina | 7. 00 |
| Calcium carbonate | 1. 84 |
| Silica | 13. 84 |
| Loss | . 06 |
| Total | 100. 00 |

No. 3, called "brown purple," is made from an ore coming from the Jackson mine, Michigan.

*Analysis of No. 3.*

| | Per cent. |
|---|---|
| Iron peroxide | 93.68 |
| Alumina | 3.06 |
| Silica | 3.20 |
| Sulphur and loss | .06 |
| Total | 100.00 |

No. 4. or "brown," is also derived from ore mined in the Lake Superior district. The value of the crude material at Cleveland is as follows: No. 1, $4.50; No. 2, $5.50; No. 3, $6.50; No. 4, $6 per ton. The prepared pigment is sold in quantities less than 5 tons at the following figures: No. 1, $30 per ton; Nos. 2 and 3, $50 per ton. The preparation consists in crushing the mineral and then grinding by several runs of buhrstones until an impalpable powder is obtained. This paint is said to have unusual anti-rust qualities, as the ores are not submitted to a calcination process. It is said to be valuable for painting railroad cars, bridges, ships, barb-wire fences, barns, wagons, carriages, roofs, shingles, agricultural implements, etc.

"*Rocky Mountain vermilion.*"—Under the foregoing title a red pigment has recently been introduced in the Eastern markets by F. W. Devoe & Co., of New York. The following information has been supplied by Mr. F. F. Chisolm: The ore is found near Rawlins, Wyoming, and is considered the most valuable deposit of its kind in the Rocky Mountain region. The mineral as it occurs is a hydrated oxide of iron with a fine dark-red color. An analysis made of this ore shows the following composition:

*Analysis of ore from near Rawlins, Wyoming.*

| | Per cent. |
|---|---|
| Iron peroxide | 90.2 |
| Sulphur and lime | 1.4 |
| Insoluble matter | 7.2 |
| Water | 1.2 |
| Total | 100.0 |

In 1878, when the mine was purchased by the Union Pacific Railway Company, the deposit was estimated to show in sight from 5,000 to 6,000 tons of the paint. The deposit has not been worked largely, the principal consumption being by the railway company. The supply during 1885 was about 200 tons, shipped directly from ore already on the dumps, so that no new material was mined. Of this amount 100 tons were used by the railway company in painting cars, water tanks,

roofs, etc., while the remainder was used by F. W. Devoe & Co. The latter firm has found a similar application for the paint, and has furnished this pigment to the elevated railway systems in New York and Brooklyn, whose structures have been coated with it. The large amount of iron contained in the paint shows its strength, and excellent results have followed from its use. The price of the ore at the mine is $30 per ton, and its value in New York is increased by the cost of transportation and grinding. It is estimated that from 2,000 to 3,000 tons of pigment made from fossiliferous iron ore are annually ground and sold by mills in Tennessee, Georgia, and Alabama.

Mr. C. G. Yale sends the following report from the Pacific coast: A pigment, some of it of an ocherous and some of a talcose nature, called mineral paint, is met with in many places in the Pacific division, especially in California. It occurs in lodes and beds and is found of various colors—yellow, brown, blue, and black. A black variety resembling asphaltum has been found in quantity on the beach in Los Angeles county. A deposit of mineral paint is known near Olmstead's Mills, Sonoma county, and another near Martinez, in Contra Costa county. A paint mine has been opened at a point 2 miles north of Reno, in Nevada. A good deal of the material obtained in the far West has been ground and found to give satisfactory results in the coarser kinds of work.

*Sienna.*—There are about twelve mines of this material in the United States, but from most of them an inferior product is obtained. The principal deposit is located in the vicinity of Bethlehem, Pennsylvania, and from it the best quality of domestic sienna is mined. The discovery of a valuable deposit at Lisbon, Maine, was reported during the year, but its quality is said by experts to be inferior to the imported. A deposit, controlled by Henry Erwin, has been opened recently at Valley station, near West End, New Jersey. A small quantity of it has been placed on the market. It is of excellent quality, and by many it is considered equal to the foreign. After it is burnt, it sells in New York at 4 cents per pound. The Bethlehem sienna sells in New York at from $25 to $30 per ton. The imported article continues chiefly in demand, and the imports at New York during 1885 were 971,854 pounds, as compared with 392,119 pounds for 1884.

*Umber.*—Owing to the steady decline in price of the Turkish umbers during the past year, the output from American mines has diminished. The principal deposits in the United States are in Pennsylvania. An amount not exceeding 1,000 tons of this pigment was placed on the market during 1885. During the year there were imported at New York 748,031 pounds of umber.

*Slate.*—The use of ground slate and similar materials mixed with white lead and ground in oil is quite common, although such paints are not sold by the large dealers. Slate by itself has little or no covering power, but in combination with other ingredients it forms a durable paint suitable for roofs and other common outdoor work.

The Grafton Paint Company mines annually in the vicinity of the works at Grafton, near Troy, New York, from 1,500 to 2,000 tons of a slaty mineral which after being ground sells in New York at from $10 to $15 per ton. The output from this deposit is variable and depends upon the condition of the weather. The spot value of the ore is about $1 per ton.

The Indiana Paint and Roofing Company, which mines slates for mantels, consumes annually a considerable amount of refuse slate, which is ground into powder at the company's quarries at Slatington, Pennsylvania. It is mixed with other pigments and ground with oil into paint. Its principal use is as a paint for roofs.

The Plastic Slate Roofing Company, of New York, manufactures a plastic slate which is composed of slate, asphalt, and oil. This material spread on roofs and exposed to the sun and atmosphere is said to be slowly reconstructed into slate stone. In this condition, it retains a certain amount of elasticity and is fire, water, and frost proof. From 150 to 200 tons of the crude slate are annually consumed, having a value of from $10 to $15 laid down in New York.

*Graphite.*—A paint is manufactured by the Joseph Dixon Crucible Company which consists of a mixture of perfected graphite and pure linseed oil, so thoroughly mixed that when applied with the brush the work receives a coat of thin flakes of graphite, and this coating once secured, it is claimed that the metal will resist any heat that iron work will ordinarily receive, and that it likewise stands extreme cold or a change from the highest heat to 40° below zero equally well, and also is not affected by acids. This paint is used for tin or metal roofs, locomotive or steamboat stacks, ashpans, and exposed ironwork. The crude graphite is obtained from the mines of Ticonderoga, New York. It is estimated that 7,500 pounds were ground into paint during 1885. The retail price of graphite paint prepared for the market is from 12 to 15 cents per pound, according to the quantity purchased.

# TALC.

By G. F. Perrenoud.

In the town of Edwards, about 11 miles in a southerly direction from Gouverneur, Saint Lawrence county, in the State of New York, there exists a large deposit of what is locally known as talc, but while its chemical components are those of this mineral, its crystallization and its physical properties but partially resemble it. Its appearance, particularly after being pulverized, would indicate that asbestus, as much as talc, entered into its composition, for, added to the unctuous feeling of the latter, it possesses in an eminent degree the fibrous nature of the former. A diligent search over an area of many miles around Gouverneur has failed to reveal the existence of this particular mineral elsewhere than at the point named. There it occurs in a bed, the dip of which is at an angle of about 45°, of a thickness varying from a few inches to 30 feet, with both hanging and foot walls of white quartzose rock. At various points along this deposit shafts have been sunk, and these have been worked as adjuncts to several mills, all within a mile or two of Gouverneur, to which the mineral is hauled by teams, to be prepared for market. As many systems as there are mills have at various times been used for pulverizing this talc, but all have been supplanted by the one existing at the present time, it being the only one found to work satisfactorily. It is as follows: The talc is first put through a crusher with jaws sufficiently close to admit of the product being received by buhrstones, to which it is conveyed; coming from these, it is placed in large iron cylinders, porcelain lined, (to prevent the contact of the talc with the iron, as this would render it valueless for the uses to which it is generally put) in charges varying from one-half to two tons, and is there kept revolving from one to three hours, according to the degree of fineness required. These are known as the Alsing cylinders, the pulverization being effected by the friction against each other and against the sides of hard flint pebbles, revolving with the charge. From these the talc is packed in burlap or paper bags, ready to be shipped to the consumer, who receives it under names varying with the fancy of the manufacturer, as pulp, mineral pulp, agalite, asbestine pulp, etc.

The stocks of the manufactured article, carried over from year to

year, having heretofore been very small, the shipments are a fair index of the annual production, and they were as follows:

*Shipments of talc from Saint Lawrence County, New York.*

| Years. | Tons of 2,000 pounds. |
|---|---|
| 1882 | 9,000 |
| 1883 | 11,000 |
| 1884 | 13,000 |
| 1885 | 15,000 |

*Companies engaged in the business of pulverizing this talc, the capacity of their plants, and capital.*

| | Capacity 24 hours. | Capital. |
|---|---|---|
| | *Short tons.* | |
| Saint Lawrence Fiber Pulp Company | 5 | $200,000 |
| Agalite Fiber Company | 15 | 600,000 |
| Natural Dam Pulp Company | 18 | 250,000 |
| Adirondack Pulp Company | 14 | 750,000 |

As these companies control the deposit, and each produces only enough for its own requirements, there is of course no price for the crude material. That of the ground stock has, within the last two years, owing to the competition resulting from the enlargement and consequent increased capacity of some of the mills, steadily declined from $16 and $18 per ton of 2,000 pounds, to $12 and $13, its present price. Some of the stock, requiring particular selection and manipulation, still commands the higher figures, but the demand for this is limited.

The uses of this material when ground are many, but with the exception of that for paper making, which industry consumes about the entire supply, none bear mention, from their want of importance. It is shipped to paper mills all over the country, where it is used as a filler in the manufacture of paper of all grades, save the very finest and the coarsest. The fibrous nature of this talc, added to its chemical properties and light specific gravity, admits of its entire amalgamation with other paper stock, thus entailing but a limited loss of material in the manufacture and hence being more economical as a filler at a higher price than would be clays and kindred materials which it replaces.

# MINERAL WATERS.

By A. C. Peale.

The returns of mineral waters received for 1885 show an increase of thirty-five in the number of springs, the waters of which were placed on the market. Notwithstanding this fact the production and its value were slightly less than during the previous year. This reduction occurred almost entirely in the North Atlantic, and Southern Central States, and is distributed among only five States in those sections, all the others showing an increase. The principal springs throughout the country not only hold their own, but report increased sales. The general decrease, which is slight, appears to be among some of the smaller and less-known springs, which in first putting the water on sale fixed the prices too high and have since had to reduce them. It is possible also that some of the reports from localities used as resorts, also included the local consumption, which has been eliminated in the reports for 1885. A number of localities used commercially as well as for resorts in 1884, sold no water during 1885, but furnished it free of charge to their guests and made no effort to push the water in the general market. A large number also have been furnishing the water at simply cost of freightage, with the view of introducing it, so that an increase may be expected in future figures.

*Alabama.*—Of the six mineral springs of Alabama, recorded as placing their waters on sale, only one makes no report for 1885, and of the five sending statistics in 1884 one reports no sales for 1885. The figures included in the statistics are made up from figures given by the following, viz: Bailey springs, Bailey Springs, Lauderdale county; Cullum springs, Bladen Springs, Choctaw county; Bladen springs, Bladen Springs, Choctaw county; Healing springs, Healing Springs, Washington county; White sulphur springs, Sulphur Springs, Calhoun county.

*Alaska* and *Arizona* report no mineral waters used commercially.

*Arkansas.*—In 1884 Arkansas reported six springs, the waters of which were used commercially. One of these now furnishes the water without charge.

The following list records the commercial waters of the State so far as we have received reports: Siloam springs, Siloam Springs, Benton county; Fairchild's potash sulphur springs, Potash Sulphur Springs, Garland county; Eureka springs, Eureka Springs, Carroll county; Mountain Valley springs, Mountain Valley, Garland county.

*California* has at least ten mineral waters of present commercial value. Only two of these were reported last year.

In the present report the following have given statistics of sales: Pacific Congress springs, Saratoga, Santa Clara county; Castalian mineral water, Olancha, Inyo county; Napa soda springs, Napa Soda Springs, Napa county; Litton's seltzer spring, Litton's Station, Sonoma county; Geyser soda spring, Litton's Station, Sonoma county.

*Colorado.*—The springs of Colorado are used mainly as resorts. Statistics have been received from but one spring in the State as to commercial use of the water, viz: Seltzer springs, Springdale, Boulder county.

*Connecticut.*—The report of the previous year contained no statistics from Connecticut, although the two springs reporting this year were noted and placed on the list. They are, Bozrah or Stark mineral springs, Bozrah, New London county; Oxford springs, Oxford, New Haven county.

*Dakota, Delaware, District of Columbia, and Florida* are not represented in the list of commercial mineral waters.

*Georgia.*—Only two springs report the sale of waters, viz: Daniel mineral springs, Union Point. Greene county; Ponce De Leon springs, Atlanta, Fulton county.

*Idaho* reports no waters on sale.

*Illinois.*—Of the four localities in Illinois whose mineral waters are said to have a commercial value, the following report their figures for 1885: Perry's springs, Perry Springs, Pike county; Zonian springs, near Elgin, Kane county; Glen Flora mineral springs, Waukegan, Lake county.

*Indiana.*—Although six of seven mineral springs of Indiana reported sales for 1884, this year only five have sent in figures. They are: West Baden springs, West Baden, Orange county; King's mineral springs, Wilson's Switch, Clarke county; New Point Comfort springs, Blue Lick, Clarke county; French Lick springs, French Lick, Orange county; La Fayette artesian well, La Fayette, Tippecanoe county.

*Indian Territory* has no mineral springs of present commercial value so far as the sale of the waters is concerned.

*Iowa.*—The list of commercial mineral waters for Iowa is increased to four, from three in the previous year. Of these, however, only the following three report figures: Ottumwa mineral springs, Ottumwa, Wapello county; Dunbar's mineral springs, College Springs, Page county; Colfax springs, Colfax, Jasper county.

*Kansas.*—The two springs on the list of Kansas mineral waters in 1884 have increased to five for 1885. They are: Iola mineral well, Iola, Allen county; Kansas artesian mineral wells, Manhattan, Riley county; Baxter's medical springs, Baxter Springs, Cherokee county; Geuda mineral springs, Geuda Springs, Sumner county; Arrington mineral springs, Arrington, Atchison county.

*Kentucky.*—The present list credits Kentucky with six springs whose waters are on the market—an increase of two over the previous year. Only three report figures of production: Upper Blue Lick springs, Davidson, Nicholas county; Bedford springs, Bedford, Trimble county; Lower Blue Lick springs, Blue Lick Springs, Nicholas county.

*Louisiana.*—So far as learned none of the Louisiana mineral waters are used commercially.

*Maine.*—Seven of the eleven springs of Maine send statistics of sales for 1885. They are: Rosicrucian spring, Rosicrucian, Lincoln county; East Boothbay spring, East Boothbay, Lincoln county; Poland mineral spring, South Poland, Androscoggin county; Auburn mineral spring, Auburn, Androscoggin county; Summit mineral spring, Hamson, Cumberland county; Hartford cold spring, Hartford, Oxford county; Scarborough mineral spring, Scarborough, Cumberland county.

*Maryland.*—The only mineral spring of Maryland reporting sales of the water is Strontia mineral spring, Brooklandville, Baltimore county.

*Massachusetts.*—The number of mineral waters on sale from Massachusetts in 1885 is reported as seven, instead of three, as given in the previous report. They are the following: Everett Crystal mineral spring, Everett, Middlesex county; Echo Grove mineral spring, Lynn, Essex county; Berkshire soda and sulphur springs, Sheffield, Berkshire county; Bethlehem springs, Holliston, Middlesex county; Commonwealth mineral springs, Waltham, Middlesex county; Allandale mineral spring, West Roxbury, Suffolk county; Crystal mineral spring, Stoneham, Middlesex county.

*Michigan.*—Four mineral springs of Michigan have waters on sale. Three of these report the sales for 1885. They are as follows: Mount Clemens mineral springs, Mount Clemens, Macomb county; Ypsilanti mineral springs, Ypsilanti, Washtenaw county; Moorman well, Ypsilanti, Washtenaw county.

*Minnesota.*—The only spring in Minnesota reporting sales of water is Inglewood spring, Minneapolis, Hennepin county.

*Mississippi* reports sales of waters from four springs in 1885 as against one in 1884. The springs reporting are Godbold mineral well, Summit, Pike county; Castalian spring, Durant, Holmes county; Chalybeate acid spring, Grenada, Grenada county; Cooper's well, Raymond, Hinds county.

*Missouri.*—Six Missouri mineral springs are included in the returns. They are the following: Mooresville mineral springs, Mooresville, Livingston county; Eldorado springs, Eldorado Springs, Cedar county; Randolph springs, Randolph, Randolph county; Reiger springs, Mercer county (P. O. address, Lineville, Iowa); Sweet springs, Brownville, Saline county; Montesano springs, Kimmswick, Jefferson county.

*Montana* has none of her mineral waters on the market at present.

*Nebraska* has no commercial mineral waters.

*Nevada* is not represented in the list of statistics for the Western States, as none of her mineral waters are put up for sale, so far as ascertained.

*New Hampshire.*—Of five springs whose waters are sold, the following four have sent in figures for 1885: Birchdale medicinal springs, Concord, Merrimack county; Bradford mineral springs, Bradford, Merrimack county; Moultonborough mineral springs, Moultonborough, Carroll county; Milford (or Ponemah) springs, Milford, Hillsborough county.

*New Jersey* has no mineral springs whose waters are found in the market.

*New Mexico.*—Joseph's hot springs, Ojo Caliente (Joseph's), Ojo Caliente, Taos county, are the only ones in New Mexico furnishing any figures for 1885, and are probably the only springs in the Territory which at present regularly utilize the waters commercially, although the water of Aztec springs is sold to some extent in Santa Fé.

*New York.*—Twenty of the thirty-four localities in New York whose waters are on sale report figures for 1885, and one, Cayuga spring, reported the waters as free.

The statistics included in the tables are based on reports from the following: High Rock spring, Saratoga Springs, Saratoga county; Vichy spring, Saratoga Springs, Saratoga county; Champion spouting spring, Saratoga Springs, Saratoga county; Star spring, Saratoga Springs, Saratoga county; Putnam spring, Saratoga Springs, Saratoga county; Union spring, Saratoga Springs, Saratoga county; Excelsior spring, Saratoga Springs, Saratoga county; Victor spring, Darien Center, Genesee county; Sharon spring, Sharon Springs, Schoharie county; Deep Rock spring, Oswego, Oswego county; Artesian lithia spring, Ballston Spa, Saratoga county; Verona mineral spring, Verona, Oneida county; Diamond Rock spring, Williamson, Wayne county; Nunda mineral spring, Nunda, Livingston county; Massena springs, Massena, Saint Lawrence county; Richfield springs, Richfield Springs, Otsego county; Chlorine springs, Syracuse, Onondaga county; Adirondack springs, White Hall, Washington county; Oak Orchard acid springs, Alabama, Genesee county; Lebanon springs, Lebanon Springs, Columbia county.

*North Carolina* has seven springs whose waters have a commercial value. Four of these have reported. One locality, Lemon Springs, which reported sales for 1884, now reports that the water during 1885 was distributed gratuitously. The following are the springs reporting figures: Panacea springs, Littleton, Halifax county; Leinster poison spring, Statesville, Iredell county; Parks alkaline spring, Casewell county (P. O. address, Danville, Va.); Seven springs, Seven springs, Wayne county.

*Ohio.*—The Ohio list for 1885 includes seven springs, an increase of one. The following have sent reports: Electro-Magnetic springs,

Woodstock, Champaign county; Green springs, Green Spring, Seneca county; Wyandot magnetic springs, Upper Sandusky, Wyandot county; Len-a-pe Magnetic springs, Delaware, Delaware county; Ohio Magnetic springs, Magnetic Spring, Union county; Cuyahoga lithia spring, Parma, Cuyahoga county.

*Oregon* has three springs whose waters are offered for sale. The two reporting are: McCallister's soda springs, 35 miles east of Jacksonville, Jackson county; Wilhoit springs, Wilhoit, Clackamas county.

*Pennsylvania.*—Five Pennsylvania springs report figures for 1885. They are the following: Black Barren mineral springs, Pleasant Grove, Lancaster county; Bedford springs, Bedford, Bedford county; Gettysburg Katalsine and Lithia springs, Gettysburg, Adams county; Minnequa springs, Minnequa, Bradford county; Gulyck and Gaylord spring, Blossburg, Tioga county.

*Rhode Island.*—The list for 1884 contained no data as to the springs of Rhode Island. Since then reports have been received from the following springs in that State: Holly spring, Woonsocket, Providence county; Ochee springs, Providence, Providence county.

*South Carolina.*—The statistics given for 1885 include figures from three of the South Carolina springs as against one for the previous year. They are: Glenn springs, Spartansburgh, Spartansburgh county; Garrett's spring, Spartansburgh, Spartansburgh county; Chick's spring, Chick's Springs, Greenville county.

*Tennessee* reports sales of eight mineral waters in the State, an increase of one as compared with the return for 1884. The springs reporting are the following: Tate's epsom springs, Tate Springs, Grainger county; Rhea springs, Rhea Springs, Rhea county; Red Boiling springs, Red Boiling Springs, Macon county; Idaho springs, near Clarksville, Montgomery county; Mineral Hill spring, Bean's Station, Grainger county; West End mineral spring, Nashville, Davidson county; Hurricane springs, Tullahoma, Coffee county; Horn's mineral spring, Lebanon, Wilson county.

*Texas* has eight springs whose waters are sold to a greater or less extent. Seven of these report as follows: Wootan wells, Wootan Wells, Robertson county; Mineral wells, Mineral Wells, Palo Pinto county: Texas sour springs, Luling, Caldwell county; Crabtree sour wells, Sulphur, Hopkins county; Sour Lake springs, Sour Lake, Hardin county; Hynson's Iron Mountain springs, Marshall, Hamson county; Dalby springs, Dalby Springs, Bowie county.

*Utah.*—So far as learned none of the Utah mineral waters are seen in the market.

*Vermont.*—Only four of the eight springs on the list, credited to Vermont, make reports for 1885. They are: Clarendon springs, Clarendon Springs, Rutland county; Alburgh springs, Alburgh springs, Grand Isle county; Elgin springs, Panton (P. O., Vergennes), Addison county; Brunswick white sulphur spring, Brunswick, Essex county.

*Virginia.*—Sixteen of Virginia's springs report sales for 1885. The entire list includes twenty-one or twenty-two springs. The following are those reporting figures: Jordan white sulphur springs, Stephenson's Depot, Frederick county; Farmville lithia springs, Farmville, Prince Edward county; Blue Ridge springs, Blue Ridge Springs Botetourt county; Seven springs, Abingdon, Washington county; Rawley springs, Rawley Springs, Rockingham county; Massanetta mineral springs, Harrisonburg, Rockingham county; Bath Alum springs, Bath Alum, Bath county; Rockingham Virginia springs, Rockingham, Rockingham county; Healing springs, Healing Springs, Bath county; Wolf Trap lithia springs, Richmond, Henrico county; Hunter's Pulaski alum springs, Dublin, Pulaski county; Rock Enon springs, Rock Enon Springs, Frederick county; Shenandoah alum springs, Shenandoah Alum Springs. Shenandoah county; Cold sulphur springs, Goshen, Rockbridge county; Wallawhatoola alum springs, Millborough Depot, Bath county; Buffalo lithia springs, Buffalo Lithia Springs, Mecklenburgh county.

*Washington Territory.*—The Medical Lake, Medical Lake, Spokane county, is the only mineral water of the Territory on sale. The waters are evaporated and the residuum is largely sold in addition to the water.

*West Virginia.*—All of the six localities of West Virginia whose mineral waters are on sale have sent reports for 1885. These springs are as follows: Greenbrier white sulphur spring, White Sulphur Springs, Greenbrier county; Salt sulphur springs, Salt Sulphur Springs, Monroe county; Irondale springs, Raccoon, Preston county; Mineral wells, Parkersburg, Wood county; Capon springs, Capon Springs, Hampshire county; Red sulphur springs, Red Sulphur Springs.

*Wisconsin.*—About fifteen of Wisconsin's mineral waters are used commercially. Of these, reports have been received from thirteen, as follows: Glenn spring, Waukesha, Waukesha county; Shealtiel springs, Waupaca, Waupaca county; Mineral Rock spring, Waukesha, Waukesha county; Vesta mineral spring, Waukesha, Waukesha county; Zenobias fountain spring, Palmyra, Jefferson county; Bethesda mineral springs, Waukesha, Waukesha county; White Rock mineral spring, Waukesha, Waukesha county; Siloam mineral spring, Waukesha, Waukesha, county; Horeb mineral springs, Waukesha, Waukesha county; Saint Croix mineral spring, Farmington, Polk county; Gihon mineral spring, Delavan, Walworth county; Iodo magnesian spring, Beloit, Rock county; Prairie du Chien artesian well, Prairie du Chien, Crawford county.

*Wyoming Territory.*—None of the mineral waters of Wyoming are used commercially.

*Summary of reports of mineral springs for* 1885.

| | Springs reporting statistics. | Springs not reporting. | Total springs used commercially. |
|---|---|---|---|
| North Atlantic States: | | | |
| Maine | 7 | 4 | 11 |
| New Hampshire | 4 | 1 | 5 |
| Vermont | 4 | 4 | 8 |
| Massachusetts | 7 | 0 | 7 |
| Rhode Island | 2 | 0 | 2 |
| Connecticut | 2 | 0 | 2 |
| New York | 20 | 14 | 34 |
| New Jersey | 0 | 0 | 0 |
| Pennsylvania | 5 | 0 | 5 |
| South Atlantic States: | | | |
| Delaware | 0 | 0 | 0 |
| Maryland | 1 | 0 | 1 |
| District of Columbia | 0 | 0 | 0 |
| Virginia | 16 | 5 | 21 |
| West Virginia | 6 | 0 | 6 |
| North Carolina | 4 | 3 | 7 |
| South Carolina | 3 | 0 | 3 |
| Georgia | 2 | 1 | 3 |
| Florida | 0 | 0 | 0 |
| Southern central States: | | | |
| Kentucky | 3 | 3 | 6 |
| Tennessee | 8 | 0 | 8 |
| Alabama | 5 | 1 | 6 |
| Mississippi | 4 | 0 | 4 |
| Louisiana | 0 | 0 | 0 |
| Texas | 7 | 1 | 8 |
| Indian Territory | 0 | 0 | 0 |
| Arkansas | 4 | 1 | 5 |
| Northern central States: | | | |
| Ohio | 6 | 1 | 7 |
| Indiana | 5 | 2 | 7 |
| Illinois | 3 | 1 | 4 |
| Michigan | 3 | 1 | 4 |
| Wisconsin | 13 | 2 | 15 |
| Minnesota | 1 | 0 | 1 |
| Iowa | 3 | 1 | 4 |
| Missouri | 6 | 1 | 7 |
| Dakota | 0 | 0 | 0 |
| Nebraska | 0 | 0 | 0 |
| Kansas | 5 | 0 | 5 |
| Western States and Territories: | | | |
| Alaska | 0 | 0 | 0 |
| Wyoming | 0 | 0 | 0 |
| Montana | 0 | 0 | 0 |
| Colorado | 1 | 0 | 1 |
| New Mexico | 1 | 1 | 2 |
| Arizona | 0 | 0 | 0 |
| Utah | 0 | 0 | 0 |
| Nevada | 0 | 0 | 0 |
| Idaho | 0 | 0 | 0 |
| Washington | 1 | 0 | 1 |
| Oregon | 2 | 1 | 3 |
| California | 5 | 6 | 11 |
| Total | 169 | 55 | 224 |

PRODUCTION.

*Natural mineral waters sold in* 1883, 1884, *and* 1885.

| | Springs reporting in 1883 and 1884. | 1883. | | 1884. | | Springs reporting in 1885. | 1885. | |
|---|---|---|---|---|---|---|---|---|
| | | Gallons sold. | Value. | Gallons sold. | Value. | | Gallons sold. | Value. |
| North Atlantic States | 38 | 2,470,670 | $282,270 | 3,345,760 | $328,125 | 51 | 2,527,310 | $192,605 |
| South Atlantic States | 27 | 312,090 | 64,973 | 464,718 | 103,191 | 32 | 908,692 | 237,153 |
| Northern central States | 37 | 1,435,809 | 323,600 | 2,070,533 | 420,515 | 45 | 2,925,288 | 446,211 |
| Southern central States | 21 | 1,441,042 | 139,973 | 1,526,817 | 147,112 | 31 | 540,436 | 74,100 |
| Western States and Territories | 6 | 169,812 | 52,787 | 307,500 | 85,200 | 10 | 509,675 | 86,776 |
| | 129 | 5,829,423 | 863,603 | 7,715,328 | 1,084,143 | 169 | 7,411,401 | 1,036,845 |
| Estimated | 60 | 1,700,000 | 256,000 | 2,500,000 | 375,000 | 55 | 1,737,000 | 276,000 |
| Total | 189 | 7,529,423 | 1,119,603 | 10,215,328 | 1,459,143 | 224 | 9,148,401 | 1,312,845 |

In the last report the figures for the northern central States included the entire output of the artesian wells of Madison, Wisconsin, the greater portion of which, however, was used as the regular city supply for domestic purposes. This consumption, although of a strictly "mineral water," is now excluded from the computation, and in the foregoing table the figures for 1883 and 1884 have been somewhat changed from those given in the preceding report, the reduction being more in point of quantity than in value.

## IMPORTS.

*Mineral waters imported and entered for consumption in the United States, 1867 to 1883, inclusive.*

| Fiscal years ending June 30— | In bottles of 1 quart or less. | | In bottles in excess of 1 quart. | | Not in bottles. | | All, not artificial. | | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | *Bottles.* | | *Quarts.* | | *Gallons.* | | *Gallons.* | | |
| 1867 | 370,610 | $24,913 | 3,792 | $360 | ..... | $137 | ..... | ..... | $25,410 |
| 1868 | 241,702 | 18,438 | 22,819 | 2,052 | 554 | 104 | ..... | ..... | 20,594 |
| 1869 | 344,691 | 25,635 | 9,739 | 802 | 1,042 | 245 | ..... | ..... | 26,682 |
| 1870 | 433,212 | 30,680 | 18,025 | 1,743 | 2,063 | 508 | ..... | ..... | 32,931 |
| 1871 | 470,947 | 34,604 | 2,320 | 174 | 1,336 | 141 | ..... | ..... | 34,919 |
| 1872 | 892,913 | 67,951 | ..... | ..... | 639 | 116 | ..... | ..... | 68,067 |
| 1873 | 35,508 | 2,326 | ..... | ..... | 355 | 75 | 394,423 | $98,151 | 100,552 |
| 1874 | 7,238 | 691 | ..... | ..... | 95 | 16 | 199,035 | 79,789 | 80,496 |
| 1875 | 4,174 | 471 | ..... | ..... | 5 | 2 | 395,956 | 101,640 | 102,113 |
| 1876 | 25,758 | 1,899 | ..... | ..... | ..... | ..... | 447,646 | 134,889 | 136,788 |
| 1877 | 12,965 | 1,328 | ..... | ..... | ..... | 22 | 520,751 | 167,458 | 168,808 |
| 1878 | 8,229 | 815 | ..... | ..... | ..... | ..... | 883,674 | 350,912 | 351,727 |
| 1879 | 28,440 | 2,352 | ..... | ..... | 3 | 4 | 798,107 | 282,153 | 284,509 |
| 1880 | 207,554 | 19,731 | ..... | ..... | ..... | ..... | 927,759 | 285,798 | 305,529 |
| 1881 | 150,326 | 11,850 | ..... | ..... | 55 | 26 | 1,225,462 | 383,616 | 395,492 |
| 1882 | 152,277 | 17,010 | ..... | ..... | ..... | ..... | 1,542,905 | 410,105 | 427,115 |
| 1883 | 88,497 | 7,054 | ..... | ..... | ..... | ..... | 1,714,085 | 441,439 | 448,493 |

It appears from the foregoing table that previous to 1873 natural mineral waters were not distinguished from the artificial waters. Since 1884 the artificial waters have not been classified according to the receptacles in which they have been imported.

*Imports for the fiscal years* 1884 *and* 1885.

| | 1884. | | 1885. | |
|---|---|---|---|---|
| | Gallons. | Value. | Gallons. | Value. |
| Artificial mineral waters | 29,366 | $4,591 | 7,972 | $2,157 |
| Natural mineral waters | 1,505,298 | 362,651 | 1,660,072 | 397,875 |
| Total | 1,534,664 | 367,242 | 1,668,044 | 400,032 |

## EXPORTS.

*Exports of natural mineral waters, of domestic production, from the United States.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1875 | $162 | 1881 | $1,029 |
| 1876 | 80 | 1882 | 421 |
| 1879 | 1,529 | 1883 | 459 |
| 1880 | 1,486 | 1884 and 1885 | None. |

The amount of artificial mineral waters exported is also trifling.

# CLASS MATERIALS.

By Jos. D. Weeks.

The chief materials used in glass making, silica, soda, potash, lime, lead, and manganese, were so fully discribed in the volume of "Mineral Resources" for 1883 and 1884, as to render unnecessary any general discussion of their production, characteristics, or uses in the report for the present year.

There are, however, some other materials to which but brief reference was made last year, and which, by reason of the extension of their use in glass making, are of growing importance, and may be described and their uses pointed out. There are also additional facts regarding some of the materials treated of in the last report, especially soda and its occurrence and manufacture in this country, that are of interest. Further, a more thorough investigation into the consumption in the glass industry of the substances which are here classified as glass materials, has made possible the presentation of more accurate statistics this year than ever before.

## COLORING MATERIALS.

In the report on glass materials in the last volume of "Mineral Resources," it was stated that several of the metallic oxides, as well as occasionally some of the other compounds of the metals, are at times found in glass as coloring materials. These were not described, however, since until quite recently but little colored glass, with the exception of common black and amber bottles, was made in this country. Now quite a number of glass works are engaged in its manufacture exclusively, and at others it forms a large part of the product. Some of the most beautiful colored glass produced in the world, rivaling in depth and richness of coloring, as well as in beauty of design, that from the famous works of Europe, is made at the flint glass works of the United States.

The coloring materials most largely employed are iron, manganese, copper, cobalt, and gold. These are generally used as oxides, though in some cases, but very rarely, other compounds are used. In addition to the above, arsenic, uranium, chromium, and silver, are occasionally employed.

As was pointed out by Bontemps, many years ago, the coloring properties of the metallic oxides are greatly modified by the degree of heat to which the glass is subjected and by other circumstances. Not

only will different temperatures give different shades of the same color, but even different colors. Manganese, for example, which is the great decolorizer of glass, so universally used for the purpose as to be known as "glass-maker's soap," is used as a colorer chiefly to impart a pink or purple to glass. If, however, the glass so colored remains too long in the furnace, it becomes pale or reddish brown, then yellow, and finally green.

From the oxides of iron all the colors of the spectrum may be produced, and in the order in which they appear in the spectrum. Its primary effect upon glass is to give it a green tinge. Hence in the manufacture of white glass, sand containing much iron is carefully avoided; what little it does contain, and there is always more or less present, is neutralized by the oxide of manganese. Oxide of iron, however, produces other colors than green. Indeed, the green of this oxide has but little brilliancy, and when rich emeralds are desired other materials, are used, such as the oxide of copper. Iron will produce in enamels, which are only glasses, a fine purplish red, or under a stronger heat an orange. If a piece of iron is thrown into the pot of a flint-glass house during the blowing, the glass in its neighborhood will be orange or yellow. In window-glass houses the addition of a small proportion of oxide of iron gives a bluish tint to the glass, while it is well known that the glass left in the pots of the bottle houses becomes an opaque blue.

Oxide of copper is chiefly used to produce reds, rubies, and purples, in the cheaper kinds of glass. To produce these reds with copper, however, requires skillful manipulation, as they are not at all fixed.

The temperature must be kept at the lowest possible point, otherwise the glass changes to a purple, and then to a sky blue with a tendency to green. A heat between the maximum, which gives a blue, and the minimum, which gives a red, produces a purple.

The finest rubies, reds, purples, violets, etc., are produced by gold. The purple of Cassius, which is a mixture of the oxides of gold and tin, or some similar preparation of gold, is used. The coloring power of gold is so great that one part of gold will give a full rich body of color to from 600 to 1,000 parts of glass. The glass colored with gold can be made to assume a scarlet, carmine, rose, and ruby.

Cobalt gives a blue which is unalterable in any fire. It is also used for some of the finer blacks.

Carbon, usually as powdered cannel coal, is the coloring matter chiefly used in the manufacture of black and amber bottles. Plumbago was at one time largely used and still is to some extent.

### SAND.

Sand is used for two purposes in glass making: as mixing sand in the batch, the melting of which produces glass, and as sand for grinding in plate-glass works, and, in the manufacture of fruit jars and similar articles, for grinding the tops, etc. In the year 1885 the amount of

mixing sand used in the glass works of the United States was 221,543 long tons, and of grinding sand, 61,284 long tons.

The sources from which the mixing sand is chiefly derived were pointed out in the last report, and its character and analysis given and discussed.

In the year just passed, the value of the mixing sand, at the works, has varied from 60 cents to $10.25 per ton; the total value of the 221,543 tons used being $507,178. The very low price of 60 cents was paid at works mining their own sand, the price covering only the labor and expense of mining, which was a trifle. The highest price was for a very fine sand, delivered at a works remote from the source of supply.

The total value of the 61,284 long tons of grinding sand used was $31,610, the average value but 51½ cents per ton, while the range of values was from 50 cents to $10, as almost all the grinding sand used was consumed at plate-glass works. This was chiefly river sand dredged out of the river or procured from the river bank near the works, and was worth only the cost of dredging or loading. At works other than plate-glass works using grinding sand, mixing sand is generally used for grinding.

### SODA.

The consumption, in the glass houses of the United States, of what is generally, though not with absolute correctness, termed soda, was as follows:

*Consumption of various sodium compounds in the glass works of the United States in* 1885.

| | Long tons. |
|---|---|
| Soda ash | 60,050 |
| Salt cake | 23,419 |
| Nitrate of soda | 2,987 |
| Common salt | 2,323 |

An interesting fact, shown by a comparison of this table with those of previous years, is the increased consumption of salt cake in the manufacture of glass. In the writer's census report on glass, it was shown that, of the total consumption of soda ash and salt cake during the census year, only 14 per cent. was salt cake. In 1885 salt cake was 28 per cent., while the actual consumption was more than four times what it was in 1879–'80.

The average price of soda ash at the glass works in 1885 was $34.18 per long ton, the range of prices from $27 to $45.33⅓, or from 1⅕ cents to 2 cents per pound, the price varying with the distance from the seaboard. The average price of salt cake was $16.95 per long ton, or about one-half that of soda ash; the range of prices was from $8 to $40 per ton. This price of $8 is probably an error.

The average price of nitrate of soda was $49.18 per ton; of salt the average price was $6.32 per long ton.

As will appear from the table given below, most of the soda ash and salt cake used in the country is imported from England. There was but one works in the country making soda ash in any considerable quantity in 1885, that of the Solvay Process Company, at Geddes, New York. This establishment with the process used was described at length in the last report. The following additional facts may be not without interest:

These works were started in the fall of 1881. The Solvay Process Company was incorporated, under the laws of the State of New York, with a capital of $300,000, for the purpose of making soda ash or carbonate of soda, under the patents of the Messrs. Solvay, and by the process as perfected by them and employed in their works in Belgium, France, Germany, Austria, and Russia, as also by their licensees in England. This process is called the ammonia process in distinction from the Le Blanc process.

The incorporators of the American company were, Hon. Rowland Hazard, of Rhode Island, and Messrs. William B. Cogswell, William A. Sweet, Earl B. Alvord, and George E. Dana, of Syracuse.

A tract of land, containing about 50 acres, was purchased, and work begun on the building in September, 1881. The site selected for the works, on this land in Geddes, about 3 miles west of Syracuse, combines good facilities both for receiving the raw materials and supplies for the manufacture and for shipping the finished product either by rail or canal. The tracks of the New York Central and Hudson River railroad enter the yard, and the Erie canal passes the shipping-room door.

The work was diligently prosecuted, and the capital increased from time to time until, in January, 1884, the manufacture was put in successful operation, with a capital of $500,000.

For the first few months the greatest difficulty was experienced in teaching the men their duties. As the work is different from that in any other establishment in this country, this could only be done by the constant and patient supervision of the small corps of assistants, who had studied in the French works of Messrs. Solvay & Co. With the hot weather of 1884 also came many troubles and difficulties which were not thoroughly understood at the time, but which have since been corrected and overcome.

The works started January 10, 1884, and should have run continuously night and day. Out of a possible 355 days they actually ran 332 days, and produced about 11,000 long tons of 58 per cent. alkali. By an accident in January, 1885, which destroyed the roof of the main building, the works were closed for 30 days. Since that time, however, they have been in continuous and successful operation. The production of 58 per cent. alkali for the year 1885 was about 15,000 long tons, notwithstanding the serious interruption in the early part of the year.

Early in the year 1885 arrangements were made to erect a second building, which would more than double the output of the works. Im-

provements and perfections were also made in the original plan, by which a much greater efficiency was obtained. The work on the new building was vigorously pushed, and was finally brought to completion early in February, 1886, and the works were successfully started. Since that time the production of 58 per cent. alkali has been at the rate of nearly or quite 40,000 long tons per year. The capital of the company was again increased, and is now $1,000,000.

The buildings erected consisted of: two main buildings, each 265 by 75 feet, and one annex 145 by 46 feet; lime-kiln building, containing ten kilns, 202 by 68 feet; boiler house, 175 by 46 feet; stack, 150 feet high, 10 inches diameter of flue; salt store house, 96 by 54 feet; one soda store house, 100 by 84 feet; one soda store house, 100 by 120 feet; machine shop, 100 by 50 feet; and other buildings, such as carpenter's shop, cooper's shop, barn, store for general supplies, office, gas works, locomotive house, pump house, sheds, and other small buildings. Altogether the ground actually covered by buildings is not far from 3 acres.

The materials handled every day require the nearly constant service of two locomotives, and consist approximately of:

| | | |
|---|---|---|
| Limestone | Long tons | 300 |
| Coal | do | 250 |
| Coke | do | 30 |
| Salt | do | 300 |
| Ammonia | do | 10 |
| The product | do | 140 |
| Barrels required | | 700 |
| Bags required | | 700 |
| Hands employed | | 500 |

Shipments can be made either by rail or canal, in bags or barrels, and a considerable quantity is shipped in bulk, but by rail only.

The consumers of the Solvay Process Company's alkali are found in every branch where soda ash can be employed. In glass making some of the most important houses use this ash exclusively. One firm has recently disposed of 50 tons of Tennant's ash in order to adopt the Solvay 58 per cent. alkali. Sales to glass makers are constantly increasing, and universal satisfaction is expressed by those who have used this ash.

For window glass the mixture of batch which has given most excellent results wherever tried is as follows:

| | Pounds. |
|---|---|
| Sand | 100 |
| Solvay 58 per cent. ash | 26 to 30 |
| Pulverized limestone | 30 to 40 |

Attention is particularly called to the use of limestone instead of lime. This has entirely obviated some of the most serious difficulties encountered in the use of Solvay process 58 per cent. alkali. The stone should be reduced so as to pass through a sieve of eight or ten meshes to

the inch. It can, in most localities, be brought to the glass works during the summer, and after grinding can be stored for use just as the sand is.

The advantages of limestone are: it is cheaper than lime; it is ready for use immediately on grinding; no shaking is required.

The troubles which some glass makers experience, with white knots or stones, with seeds or "lousy" glass, and with cordy or streaked glass, seem all to disappear in the use of this mixture. The reason for this is easily found. Limestone, which is mainly carbonate of lime, contains from 40 to 44 per cent., by weight, of carbonic acid. When fusion takes place this gas, together with that from the carbonate of soda or soda ash, is released, and the mechanical action of this doubled volume of gas, in bubbling up through the liquid mass, mixes the contents of the pot most thoroughly, and insures a good melt. The glass made from this mixture has a greater and more permanent luster than that made with lime.

The mixture above can be varied within the limits given, without much apparent effect on the glass, and should be changed by each maker according to the quality of the sand and stone used. More limestone makes the glass harder. More alkali makes it softer.

In soap making, the Solvay Process Company's 58 per cent. alkali gives entire satisfaction. Many large houses are using it for the greater part of their alkali, and some use no other whatever.

In paper making, from the first, this alkali has been received with caution; but the success, where experiments have been made, is flattering and convincing. New buyers in this business are constantly coming forward.

In dyeing and bleaching, in cotton and woolen mills, the Solvay 58 per cent. has largely replaced caustic and crystals of soda, and wherever once introduced has always been retained, both on account of the better results obtained and the economy effected in its use.

For machinists' use, a quality of ash which contains a little dirt and is discolored, made up of the sweepings of the works, is just as serviceable as the best crystals, and 1 pound of it has the same effect as 3 of crystals. For cleaning boilers, and keeping them free from scale, or softening the scale when once formed, provided the scale arises in part or in whole from sulphate of lime contained in the feed water, this dirty discolored soda ash is as good as 58 per cent. alkali, and is sold at lower price. It has been in use at many works in and near Syracuse for more than a year, and has given most satisfactory results.

Among the industries in which the soda is used, in addition to those already noted, are starch, sugar, glucose, oil refining, candles, aniline dyes, wood pulp, pyroligneous products, citrate and sulphite of soda, acetates, etc., earthenware and pottery, salt purification, silicate of soda, dynamite, and many others.

The Solvay Process Company intends soon to prepare a purified supercarbonate of soda, and to place it on the market. The manufact-

ure of a portion of its product into caustic soda is also contemplated in the near future.

The following table, which shows the imports of alkali from England for the past sixteen years contrasted with the production at Syracuse, may be of interest:

*Imports of soda ash compared with domestic production at Syracuse.*

| Years ending June 30— | Imported. | Made at Syracuse. | Total. |
|---|---|---|---|
| | *Long tons.* | *Long tons.* | *Long tons.* |
| 1870 | 95,182 | | |
| 1871 | 96,225 | | |
| 1872 | 109,491 | | |
| 1873 | 107,466 | | |
| 1874 | 104,553 | | |
| 1875 | 101,878 | | |
| 1876 | 116,994 | | |
| 1877 | 117,551 | | |
| 1878 | 121,975 | | |
| 1879 | 150,029 | | |
| 1880 | 164,609 | | |
| 1881 | 155,655 | | |
| 1882 | 175,939 | | |
| 1883 | 172,071 | | |
| 1884 | 156,158 | 11,000 | 167,158 |
| 1885 | 167,083 | 15,000 | 182,083 |

From the above it will be seen that only a small percentage of the consumption of the country is supplied by home manufacture.

The selling price of the Syracuse soda ash for 1885 was from $1.10 to $1.15 per 100 pounds, 48 per cent. alkali, equal to $29.77 to $31.12 per 2,240 pounds 58 per cent.

In addition to the works especially erected for the manufacture of soda ash under the Solvay process at Syracuse, the Eureka Chemical Company, of Watertown, New York, is building a new works at Syracuse for the manufacture of fine sulphate of soda, especially adapted to glass-makers' use. This works will employ, essentially, the Le Blanc process, but with greatly improved and more economical apparatus. The by-products will all be utilized, and by the methods adopted it is claimed that a perfectly pure sulphate of soda can be produced at a very moderate cost, and as it is the high price at which sulphate of soda has been sold that has interfered with its use, this company believes that the reduced cost will lead to a return to the use of soda ash at many works that have recently employed salt cake and the cheaper substitutes for soda ash.

### THE NATURAL SODAS OF THE WEST.

During the past year, for the first time, a systematic effort has been made to work the soda deposits of Wyoming, and to establish a market for the product in the growing and prosperous towns of the West. No attempt has been made to manufacture anything but the commercial caustic soda, for which quite a ready sale can be had. Lack of railway facilities has held back the development of any beds but those near Laramie.

The soda property generally known as the "Union Pacific lakes" lies about 13 miles nearly due south of Laramie, and is reached by a branch of the Union Pacific railway. The property embraces some 2,000 acres, including five "lakes," in all but one of which the soda is solid. These lakes are connected, and seem to drain one into another. All of the soil near Laramie is more or less impregnated with the sulphate of soda, and the common sources, it is believed, are springs, water from which bears large percentages of soda salts.

The physical condition of the soda in the lakes varies much with the season. In wet years the soda is almost fluid, while in dry years in all but one of the lakes it is solid, and in this one it occurs as a saturated solution. In the solid lakes the soda contains many thin layers of mixed clay and soda. Analysis of a sample of this mixture shows:

*Analysis of deposits of soda salts at Laramie, Wyoming.*

| | Per cent. |
|---|---|
| Iron, lime, magnesia | 22.33 |
| Alumina, soda, hydrochloric and sulphuric acids | 40.82 |
| Silica | 36.85 |
| Organic matter | Traces. |
| Total | 100.00 |

The soda when taken pure contains large quantities of water, which fact interferes seriously with its employment in the manufacture of sodium hydrate.

Its composition varies only slightly, and the following may be taken as typical analyses:

*Average analyses of soda deposits near Laramie, Wyoming.*

| | 1. | 2. | 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Sulphate of soda | 44.55 | 41.41 | 39.78 |
| Water | 54.98 | 54.79 | 59.66 |
| Insoluble matter | .47 | 3.8 | .56 |
| Total | 100.00 | 100.00 | 100.00 |

These lakes are the only ones from which soda is being taken for use.

The soda works near Laramie were built by the Union Pacific Railway, and leased to Mr. Howard Hinckley. The process used is the old "black ash," with stationary furnace. The capacity of the works is about 2 tons of sodium hydrate per day. The capacity of the furnace is 3½ tons of sodium sulphate per day. Re-screened coal from the Rock Spring mine is used, and the limestone necessary is obtained near Laramie. The "black balls" formed of the fused soda, coal, and lime, are broken up and washed in four lixiviating pans, and the liquor is then taken to two settling vats. Thence it is drawn to the "causticizer,"

which is a large circular tank, in which are two perforated vessels containing caustic lime, around which the solution of sodium carbonate is agitated. After the causticizing, the liquor is passed through three long circular iron settlers. The clear liquor is then drawn to the "V pan," where waste heat is used to aid the evaporation of the solution. The slightly concentrated liquor is then drawn to the "boat pan," which is set upon the reverberatory furnace. The evaporation is continued as long as possible, and the new concentrated solution is then drawn to another room, into the "finishing pot." This is a large cast-iron pot, set directly over a furnace. Here all remaining traces of water are driven off at a low red heat. The hydrate at this stage is generally nearly black. Small quantities of niter are added to the fused mass to whiten it. The hydrate is then ladled into sheet-iron vessels and shipped. Some of the Laramie caustic soda has been used by the Denver Soap Company, which reports favorable results from its use. The works at Laramie are not well adapted to the most economical handling of the soda. Improvements are now being made by which the number of men employed will be greatly reduced and the composition of the "black balls" made more uniform.

When the soda works were first begun it was supposed that the natural occurrence of the material as a sulphate, rendering unnecessary the reduction of the chloride to the form of a sulphate, would greatly decrease the ultimate cost of the caustic soda; but it was found that the very large quantity of water present in the soda as it comes from the lakes more than offset, by the trouble and delay it caused in the furnaces, the gain in the natural form of the soda.

The Laramie works produced from July to January, 1885, about 30 tons of caustic soda. Defects in the plant have caused great delay and loss of some of the caustic soda, and it has been decided to close the works until alterations now being made can be completed. The lessee of the works states that good reports of the caustic soda have been made by users of it.

The "Donney" soda lakes are situated about 18 miles southwest of Laramie, and are three in number, covering, approximately, with the land included, 520 acres. In one lake the deposit is 11 feet thick; in the others it is 5 to 6 feet. The soda from these lakes is similar to that from the Union Pacific lakes, and there seems to be an underground connection between the two groups. In boring an artesian well near these lakes to prospect the underlying strata a brine was obtained, which, upon analysis, showed—

*Analysis of brine from near the Donney soda lakes.*

| | Grains per gallon. | Per cent. |
|---|---|---|
| Sodium chloride | 2,002 | 2.86 |
| Sodium sulphate | 770.2 | 1.10 |

The large percentage of salt is very curious, as only traces of it are found in these lakes.

The soda deposits in Carbon county are situated in the Sweetwater valley, near Independence Rock, and nearly 50 miles due north of Rawlins. These deposits contain both carbonate and sulphate of soda, and are generally known as the "Dupont Lakes." The lakes are four in number, and vary from 6 to 2,000 acres in area, and are held by United States patents in the name of L. Dupont. There are five claims known as—

| | Acres. |
|---|---|
| New York soda mine | 160 |
| Philadelphia soda mine | 80 |
| Omaha Soda mine | 20 |
| Wilmington soda mine | 160 |
| Wilkes Barre soda mine | 20 |

The Omaha soda mine includes 20 acres, of which about 5 are covered with carbonate and sulphate of soda, mixed with a little chloride of sodium and sand blown in from the surrounding soil. Several bore holes were put down, and show an average thickness of about 6 feet.

*Amount of carbonate of soda contained in the different samples.*

| | |
|---|---|
| No. 1, 3½ feet from surface ..... per cent.. | 24.62 |
| No. 2, surface ..... do.... | 41.55 |
| No. 3, surface near shore ..... do.... | 32.42 |
| No. 4, water ..... pounds per gallon.. | 1⅛ |

A fused sample showed 52.23 per cent. of carbonate of soda. A fuller analysis of a sample taken from the surface showed:

*Analysis of surface soda from Carbon county, Wyoming.*

| | Per cent. |
|---|---|
| Moisture | 9.01 |
| Insoluble | 2.61 |
| Sulphate of soda | 25.75 |
| Chloride of sodium | 2.13 |
| Carbonate of soda | 30.62 |
| Bicarbonate of soda | 30.09 |
| Total | 100.21 |

Another sample from near the surface contained 56.3 per cent. of water.

*Analysis of dry salt.*

| | Per cent. |
|---|---|
| Chloride of sodium | 0.65 |
| Sulphate of soda | 59.29 |
| Carbonate of soda | 27.60 |
| Insoluble matter | 1.20 |

The variations and the proportion of sulphate and carbonate of soda are shown by the following table, the samples having been dried:

| Samples. | Chloride of sodium. | Sulphate of sodium. | Carbonate of sodium. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Five feet below surface | 0.979 | 64.05 | 15.60 |
| Five feet below surface | .32 | 65.08 | 16.70 |
| Surface | .81 | 17.02 | 80.60 |

The Wilkes Barre claim is about one mile west of the Omaha, and the soda is in solution.

Samples of this solution showed by analysis:

| | Carbonate of soda. |
|---|---|
| No. 1.....grains per gallon.. | 3,728 |
| No. 2.....do.... | 4,905 |

The Wilmington claim is located one-quarter of a mile west of the Wilkes Barre, and covers 160 acres. The soda here is also in solution. Its depth has never been determined. It has been sounded with a 40-foot rope without finding bottom in the center. A sample of the solution contained 2,343 grains of carbonate of soda per gallon.

A sample which had crystallized out by cold, when dried, showed:

| | Per cent. |
|---|---|
| Chloride of sodium | 1.83 |
| Sulphate of soda | 39.04 |
| Carbonate of soda | 59.00 |
| Insoluble matter | 9.23 |

The New York and Philadelphia claims are both upon one lake, which is solid, and is 4 miles west of the Wilmington. Two bore holes have been put down in this lake. One, at a distance of 50 feet from the shore, showed 4 feet of soda; the other, at a distance of 230 feet from the shore, passed through 14 feet of solid soda without touching bottom.

Three samples taken from this lake showed as follows:

| | No. 1. | | No. 2. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Chloride of sodium | 1.83 | 2.04 | 2.52 |
| Sulphate of soda | 71.37 | 44.77 | 72.40 |
| Carbonate of soda | 3.10 | 5.00 | 5.10 |
| Insoluble matter | 22.82 | 47.50 | 19.03 |

Fifteen miles from these soda deposits, in the Seminoe mountains, good limestone occurs, containing 2 per cent. of magnesia. Near the limestone is a good 8-foot vein of coal.

A comparison of the analyses from the Donney and Union Pacific lakes, and those from the Dupont lakes, show how much greater the percentage of carbonate of soda in the latter is. The Sweetwater country is still out of the reach of transportation, and until a railway is built in this direction, these soda deposits must remain undeveloped. Great aid, in the way of analyses and reports, has been given by Mr. Howard Hinckley, of Laramie, Wyoming, and by Mr. Irving A. Stevans, of Wilkes Barre, Pennsylvania.

### LIME.

The lime used in the glass works of the United States, in 1885, amounted to a total of 43,168 long tons, of which 10,594 tons were used as caustic lime, and 32,574 as limestone. Here again, as in the case of soda ash and salt cake, and, as a result of the change from ash to cake, the consumption of the cruder material, limestone, has largely increased since the census year.

The average value of the caustic lime used at the works was $5.94 a ton, the range of value from $3.11 to $18.66⅔; the average value of the limestone $4.31 a ton; the range of value from $1.21 to $7 a ton.

### MANGANESE.

During the year 1885, there was considerable activity in searching for manganese deposits in the United States, and the output was largely increased over that of the preceding year. The statistics of this production are given in the article on manganese. But little manganese suitable for the use of the glass-makers has as yet been found in the United States. The supplies are imported chiefly from New Brunswick and Nova Scotia, and from Europe. Considerable manganese is produced in Chili and Russia, some of which is suitable for glass making.

### OTHER MATERIALS.

The other materials for glass works do not call for special remarks.

The amounts used, the total average value per cent., and range of value per cent. are given in the table accompanying this report.

### CONSUMPTION OF MATERIALS IN THE MANUFACTURE OF GLASS IN 1885.

In the following table will be found consolidated the statements received of the total amounts of the chief materials consumed in the manufacture of glass in the year 1885. The ton used is uniformly 2,240 pounds.

Under the previous headings most of these figures have been discussed. It is only necessary to say here that, with the exception of the writer's census report, this, so far as has been learned, is the first attempt to compile a statement regarding the materials used in the glass industry of the United States. It may be also proper to say here that the variations in the prices of these materials, the bulk of which is imported, is owing to the distance from the sea-board. The price of materials produced in this country varies with the nearness of the works to the source of supply and the cost of labor at the place at which they are produced.

*Amounts and value of the chief materials used in glass making in the United States in the year* 1885.

| Materials. | Amounts. | Total value. | Average value, per unit. | Range of value, per unit. |
|---|---|---|---|---|
| Mixing sand.....long tons.. | 221,543 | $507,178 | $2.28 + | $0.60 to $10.25 |
| Grinding sand.....do.... | 61,284 | 31,610 | .51 + | .50 to 10.00 |
| Soda ash.....do.... | 60,050 | 2,052,758 | 34.18 + | 27.00 to 45.33 |
| Salt cake.....do.... | 23,419 | 396,963 | 16.95 + | 8.00 to 40.00 |
| Nitrate of soda.....do.... | 2,987 | 146,900 | 49.18 | 25.00 to 120.00 |
| Common salt.....do.... | 2,323 | 14,684 | 6.32 + | 5.00 to 20.00 |
| Lime, caustic.....do.... | 10,594 | 62,993 | 5.94 + | 3.11 to 18.66 |
| Limestone.....do.... | 32,574 | 140,497 | 4.31 + | 1.21 to 7.00 |
| Potash.....do.... | 443½ | 50,480 | 113.82 + | 110.00 to 140.00 |
| Pearl ash.....do.... | 15 | 1,750 | 116.66⅔ | 110.00 to 135.60 |
| Red lead.....pounds.. | 696,000 | 37,118 | .05⅓− | .05 to .06 |
| Litharge.....do.... | 2,081,240 | 112,794 | .054+ | .05 to .05½ |
| Arsenic.....do.... | 1,105,973 | 35,772 | .032+ | .02½to .09½ |
| Manganese.....do.... | 293,850 | 16,589 | .056+ | .03½to .08¾ |
| Fireclay.....long tons.. | 17,794½ | 319,056 | 17.93 + | 2.00 to 35.00 |
| Clay pots.....number.. | 5,085 | 200,631 | 39.45 + | 25.75 to 50.00 |

### IMPORTS AND EXPORTS OF GLASS.

In the two following tables will be found a statement of the imports and exports of glass and glassware into and from the United States.

The exports cover the period since 1791. The imports date back to 1867. The variety of these exports is such that it is almost impossible to give the contents. The exports are what is chiefly known as glassware, that is, table-ware and similar articles. The imports of all grades, from the coarsest black bottle to the finest artistic ware, including table-ware, looking-glasses, bottles, and colored glass, were:

*Glass and glassware of domestic production exported from the United States.*

| Fiscal years ending September 30, until 1842, and June 30 since— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1791 | $10 | 1856 | $216,439 |
| 1826 | 44,557 | 1857 | 179,900 |
| 1827 | 59,307 | 1858 | 214,608 |
| 1828 | 51,452 | 1859 | 252,316 |
| 1829 | 49,900 | 1860 | 277,948 |
| 1830 | 60,280 | 1861 | 394,731 |
| 1831 | 102,736 | 1862 | 523,906 |
| 1832 | 106,855 | 1863 | 998,569 |
| 1833 | 93,494 | 1864 | 793,650 |
| 1834 | 79,229 | 1865 | 1,268,533 |
| 1835 | 79,808 | 1866 | 621,391 |
| 1836 | 46,877 | 1867 | 654,689 |
| 1837 | 44,950 | 1868 | 609,708 |
| 1838 | 37,881 | 1869 | 580,718 |
| 1839 | 43,448 | 1870 | 530,654 |
| 1840 | 56,688 | 1871 | 466,447 |
| 1841 | 43,095 | 1872 | 547,112 |
| 1842 | 36,748 | 1873 | 627,562 |
| 1843 (*a*) | 25,348 | 1874 | 731,827 |
| 1844 | 77,860 | 1875 | 691,310 |
| 1845 | 98,760 | 1876 | 628,121 |
| 1846 | 90,860 | 1877 | 658,061 |
| 1847 | 71,155 | 1878 | 869,682 |
| 1848 | 76,007 | 1879 | 768,644 |
| 1849 | 101,419 | 1880 | 749,866 |
| 1850 | 136,682 | 1881 | 756,022 |
| 1851 | 185,436 | 1882 | 864,235 |
| 1852 | 194,634 | 1883 | 998,857 |
| 1853 | 170,561 | 1884 | 829,756 |
| 1854 | 229,382 | 1885 | 783,915 |
| 1855 | 204,679 | | |

*a* Nine months.

*Glass, and manufactures of, imported and entered for consumption in the United States, 1867 to 1885, inclusive.*

| Fiscal years ending June 30— | Value. | Fiscal years ending June 30— | Value. |
|---|---|---|---|
| 1867 | $3,744,557 | 1877 | $3,952,751 |
| 1868 | 3,111,232 | 1878 | 3,331,980 |
| 1869 | 3,985,686 | 1879 | 3,281,453 |
| 1870 | 4,086,329 | 1880 | 5,133,285 |
| 1871 | 4,450,725 | 1881 | 5,862,270 |
| 1872 | 6,776,951 | 1882 | 6,753,537 |
| 1873 | 6,945,982 | 1883 | 7,597,897 |
| 1874 | 5,447,355 | 1884 | 7,553,185 |
| 1875 | 5,756,706 | 1885 | 6,340,721 |
| 1876 | 4,804,544 | | |

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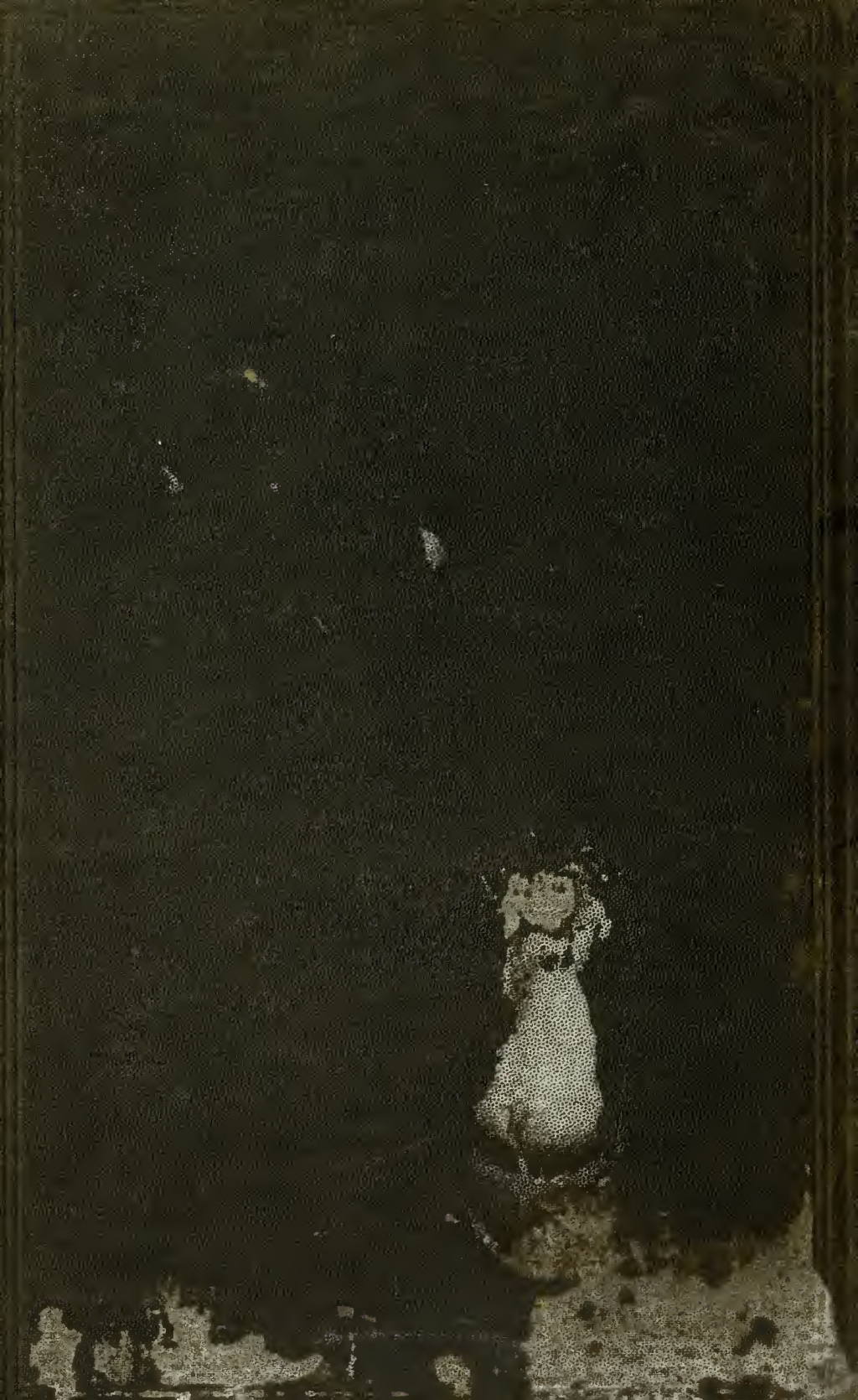
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